terra australis 17

The archaeology of Lapita dispersal in Oceania

Papers from the Fourth Lapita Conference, June 2000, Canberra, Australia




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The archaeology of Lapita dispersal in Oceania

Papers from the Fourth ~~Lapita~~ Conference, June 2000, Canberra, Australia

Edited by
G.R. Clark, A.J. Anderson and T. Vunidilo

PANDANUS BOOKS
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Cover:
Main: Ugaga Island in Fiji, where a small Lapita site is located (A. Anderson).
Top left to right: Modelled clay face with dentate-stamped markings from Boduna Island, PNG (R. Torrence); Trochus shell fish hook from the Arawe Islands, West New Britain (A. Smith); excavations on Ugaga Island, Fiji (A. Anderson); modified Trochus shell from the Arawe Islands, PNG (A. Smith).

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Introduction

It was to have been the turn of Fiji to host the quadrennial Lapita Conference but the contemporary reality of an increasingly destabilised post-colonial Pacific intervened in the shape of a coup on 19 May 2000, just a fortnight before participants were due to arrive. It would have been the first major archaeological conference in the archipelago since the 1969 Wenner-Gren Symposium on Oceanic Culture History. To salvage the event it was relocated to the more prosaic setting of the Australian National University, a location in winter which lacks the tropical cachet of the Pacific, but which is well supplied with the people and facilities essential to run an international conference at short notice. The sudden change in venue unfortunately meant that some people were unable to alter their travel plans and make it to Canberra, particularly colleagues from North America. Nevertheless, around 60 Pacific scholars from Japan, Hawaii, New Caledonia, France, Fiji and Australasia did participate and delivered more than 40 papers, which besides providing an overview of current archaeological research on the west and central Pacific, also took us a step further toward understanding the Lapita phenomenon.

This volume collects the key papers of the conference which, with one exception, can be grouped into four themes. The first addresses the distribution of Lapita sites from the Bismarck Archipelago to Samoa. New and fundamental data on the age, number and distribution of Lapita sites are presented by Anderson et al., and Felgate and Summerhayes. In a separate paper, Anderson employs this data to argue that there was variable mobility during the Lapita dispersal. Secondly, three papers consider questions about Lapita use of the environment (Davidson and Leach, Parr et al., Szabo). A third group of papers concerns the artefacts and sites of the post-Lapita period, in an attempt to delineate more clearly the transitions seen in prehistoric material culture suites and patterns of landscape use (Bedford, Bedford and Clark, Leavesley, Parke, Sand, Spriggs and Bedford, Valentin et al.). Sand, for example, convincingly demonstrates differential rates of change in several classes of non-pottery artefacts, to illuminate the drivers and significance of culture change in New Caledonia over 3000 years. Fourthly, several authors investigate, and in some cases challenge, the view that Lapita arrived in the Bismarck Archipelago as a complete package from Island Southeast Asia (Bulmer, Cameron, Hagelberg, Smith). If this is so, then why, they ask, do spindle whorls not occur in Lapita sites, and why do *Trochus* shell working and possibly the domestic dog, have a pre-Lapita age in Island Melanesia? Most unusually, the exceptional paper for a Lapita conference is one devoted exclusively to Lapita ceramics. Torrence and White report the spectacular find of modelled ceramic faces with dentate-stamped decoration (cover photo) from Boduna Island and discuss implications for understanding the Lapita design system.

If the papers in this volume suggest that there are changing interests in Lapita and its descendant assemblages, they also demonstrate how far we remain from definitive solutions to questions about origins which emerged soon after the inception of Lapita scholarship. The relative simplicity of articulating the pertinent questions still contrasts starkly with the difficult business of constructing useful databases in the field and laboratory. Nevertheless, this volume represents a recent and substantive contribution toward further understanding.

The decision not to proceed with the Fijian conference had to do with practicalities and personal safety but there were political implications which could not be ignored. Some participants felt that attending a conference in Fiji might be seen as offering tacit support to an administration that had taken control of the country at gunpoint. The issue raised an ethical dilemma for researchers, the implications of which go beyond Fiji's shores. The coup in Fiji is symptomatic of a broader political instability sweeping the Asia–Pacific region, which presents particular challenges to archaeologists and indeed all researchers seeking to study in the area. Should we boycott any country that is not under democratic rule? Or one where human rights are abused? These are not simple questions when the turmoil is linked, as so often it is, to indigenous movements centred upon control of land. Archaeologists cannot avoid making political decisions in these cases, but do the nature and recent history of our discipline enjoin sympathy for indigenous aspirations or ought we to adopt broader perspectives? This is a dilemma, both personal and professional, that will only recur in the Pacific's current troubled economic and political climate.

The Centre for Archaeological Research, Australian National University, provided generous funding for the conference and we also thank the Department of Archaeology and Natural History and the School of Archaeology and Anthropology (ANU) for their support. The Research School of Pacific and Asian Studies provided airfares that allowed two representatives from the Fiji Museum to attend, for which we thank the Director, Professor Jim Fox. We are grateful to all the participants who made last-minute travel arrangements in order to divert to Canberra. The Fiji Museum kindly arranged beautiful pandanus bags for all participants. For assistance with conference facilities, refreshments and social events we thank Gillian Atkin, Belinda Barbour, Stuart Bedford, Matthew Campbell, Peta Hill, Geoff Hope, Matthew Leavesley, Lyn Schmidt and Matthew Spriggs.

The Editors

Contents

An inventory of Lapita sites containing dentate-stamped pottery

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Introduction

Recent estimates of the number of Lapita sites now recorded have varied considerably. Green's review in 1979, and his map (Green 1979:Fig. 2.2), still quoted, counted 19 localities and about 60 sites. Kirch and Hunt (1988) counted 79 sites and Kirch's (1997) review estimated more than 100 sites. A paper on Lapita colonisation models (Anderson n.d.), at the Fourth Lapita Conference, suggested 112 sites. Informal counts by regional specialists (Bedford, Burley, Clark and Summerhayes) during the conference and several months later, at the Pacific 2000 Conference in Hawaii, indicated that the number might be up to about 180 sites — distributed as 90 in the western islands, 40 between the Reefs, Vanuatu and New Caledonia, and 50 in the eastern islands. In fact, our inventory (below) lists 184 sites (broad density distribution shown in Fig. 1). These data suggest that current understanding amongst archaeologists of the total abundance of Lapita sites is at variance with the sum of the data that can be accumulated from each area. In other words, the regional evidence needs to be brought together again, as it has been in the earlier publications noted above.

It is not a simple matter, however, because much depends upon how 'Lapita' is defined, even when the definition is restricted to ceramics. Exactly where and how a line is drawn between Lapita ceramics and the various wares that were contemporary with them, or replaced them, is an abiding issue of Pacific prehistory. It is difficult because many assemblages to which nobody would refuse the label 'Lapita' contain, in addition to undisputed Lapita wares, others which in form and decoration (or the lack of decoration) can be assigned to post-Lapita assemblages: plain wares, some styles of incised decoration, applique and so on. As in many other areas of archaeology, much depends upon individual preference and purpose. Tracing the legacy of Lapita in successive ceramic types will take a more inclusive view than seeking to define the initial Lapita assemblage, for example. Choices need to be made and ours is based on the following considerations.

A principal division in perception, still evident amongst Pacific archaeologists, which was outlined by Jack Golson (1971:75) and Roger Green (1974:251) 30 years ago, lies between seeing Lapita ceramics as the manifestation of an archaeological *horizon*, and viewing Lapita pottery as representing an archaeological *tradition* — using the terms as defined by Willey and Phillips (1958). Each viewpoint has specific interpretive problems.

If Lapita is seen as a ceramic tradition extending across a large area of Near and Remote Oceania, and occupying a time depth of 1000 years or more, then the term 'Lapita' includes the plain wares of Tonga and Samoa, as well as the Buka-style pottery of Watom, even though there is little stylistic similarity between the plain wares of Tonga and the plain wares of Samoa, let alone between either of the plain wares and Buka-style pottery. In this case 'Lapita' refers to local or regional pottery sequences that demonstrate technological or stylistic continuity from an initial Lapita ceramic assemblage, however that might be defined.

The important point is that the trajectory of ceramic development from the first Lapita assemblages might, and indeed appears to, follow quite different paths in the archipelagos of the west and central Pacific (Bedford and Clark this volume). Confusion can arise since the term 'Lapita' then includes ceramic elements that are early and widespread (Lapita *sensu stricto*) with those that are later and limited to smaller districts or areas (Lapita *sensu lato*). Spennemann (1989:68), for example, identified a continuous sequence of ceramic development on Tongatapu, and therefore used 'Lapita' as a synonym for 'ceramic', which seems too broad a definition to be archaeologically meaningful since pottery was produced on Tongatapu for 1500 years, about half of the entire prehistoric sequence.

The interpretation of assemblages containing a proportion of dentate-stamped pottery as representing an archaeological horizon, defined as "a primary spatial continuity represented by cultural traits and assemblages whose nature and mode of occurrence permit the assumption of a broad and rapid spread" (Willey and Phillips 1958:33), can also be problematic. First, there is some evidence to suggest that dentate-stamped pottery begins earlier and continues longer in Near Oceania than in Remote Oceania, and the concept of a Lapita ceramic horizon, as opposed to a tradition, might therefore be inappropriate in the west. In Remote Oceania, on the other hand, the ceramic evidence generally supports an interpretation as an archaeological horizon. Second, and in line with the definition above, defining an archaeological horizon on the basis of one or two ceramic criteria can provide a misleading picture of cultural homogeneity that obscures important aspects of social variability (see Clark and Anderson In press). The likelihood of significant cultural variation amongst the western Pacific Lapita groups seems plausible because of the longer time depth and the different kinds of interaction that might be expected between Lapita and non-Lapita (probably non-Austronesian-speaking) populations. To characterise Lapita only on the basis of a numerically minor form of the ceramics has a potentially different implication than in Remote Oceania where, it is assumed, colonising populations were smaller and more homogeneous and the dentate-stamped pottery, though still a minor element, more representative of the restricted variety.

Given, then, that interpretations of 'Lapita' ceramics legitimately embrace aspects of both *horizon* and *tradition*, how might we proceed to delineate a Lapita entity? Clearly, this depends on what we are trying to find out, and our aim at this stage in Lapita research is relatively modest. We want to specify the currently recorded number and distribution of Lapita sites, using one explicit criterion which is found throughout the Lapita range and which defines Lapita against all other known assemblages in the region in which Lapita occurs. The obvious criterion is dentate-stamped decoration (cf. Kirch and Hunt 1988:28). Other aspects of Lapita ceramics such as vessel form, technology and other decorative techniques might be equally as informative, but they have yet to be reported in sufficient detail for use in a distributional study of this kind. The dentate-stamped criterion has at least the virtue of providing a Lapita-wide foundation of site abundance and other site characteristics that is uncontroversial and upon which more complex inventories and arguments can be based.

Why do this at all? Several answers may be given. First, just as for the sake of a common understanding of our subject it is important to agree on criteria about characterising Lapita pottery form and decoration, so it is necessary for Lapita specialists to reach a broad agreement from time to time about how many sites we are dealing with and which ones. Second, as the archaeology of the Lapita phenomenon becomes richer in data of all kinds we need to try to understand what Lapita is, and is not, in terms other than the formal attributes of its material culture and the demonstrated and conjectured nature of its settlement patterns and economy. That it represents a substantial migration by people who in some sense were the earliest Neolithic populations in the region and the first people in the eastern archipelagos is clear enough. But a deeper understanding of the migration and colonisation processes and results depends also on attempting questions such as how numerous were the first settlers, how often and fast did they move, which kinds of localities did they prefer to settle first and why, what set the process going and where and why did it stop. These are all fundamental issues of studies in prehistoric migration and colonisation throughout world archaeology and to the investigation of which Lapita studies might also aspire. To do so, control over the facts of Lapita site abundance, distribution and age is essential.

Information in the inventory

Table 1 shows the complete list, so far as our information extends, of archaeological sites containing dentate-stamped pottery. National site register codes are given where available and the site name. Locality type is approximate and many sites might fall under more than one description but we have taken the description which provides the most distinctive information, i.e. given that all sites are on islands and nearly all are coastal, what additional feature of location, if any, distinguishes them. A brief description of site contents is similarly subjective but indicates at least whether the site was a pottery find spot, a small deposit of restricted diversity or a full settlement site. The ceramic series is the local series; that is, where the ceramics fall in the local sequence. Although description of the Lapita ceramic series throughout its range is becoming more precise and perhaps better understood in developmental terms (e.g. Summerhayes 2000a), it is not yet possible to place all sites or levels containing dentate-stamped ceramics into a single Lapita-wide framework. Age is given approximately and according to relevant radiocarbon dates, in calendrical years BP.

Indicator references are simply one or two essential references to get the reader into the area of publications from which additional data may be drawn. We emphasise here that this inventory is only a summary of the information available. We urge readers to go through the indicator references to reach the original site reports and specific publications.

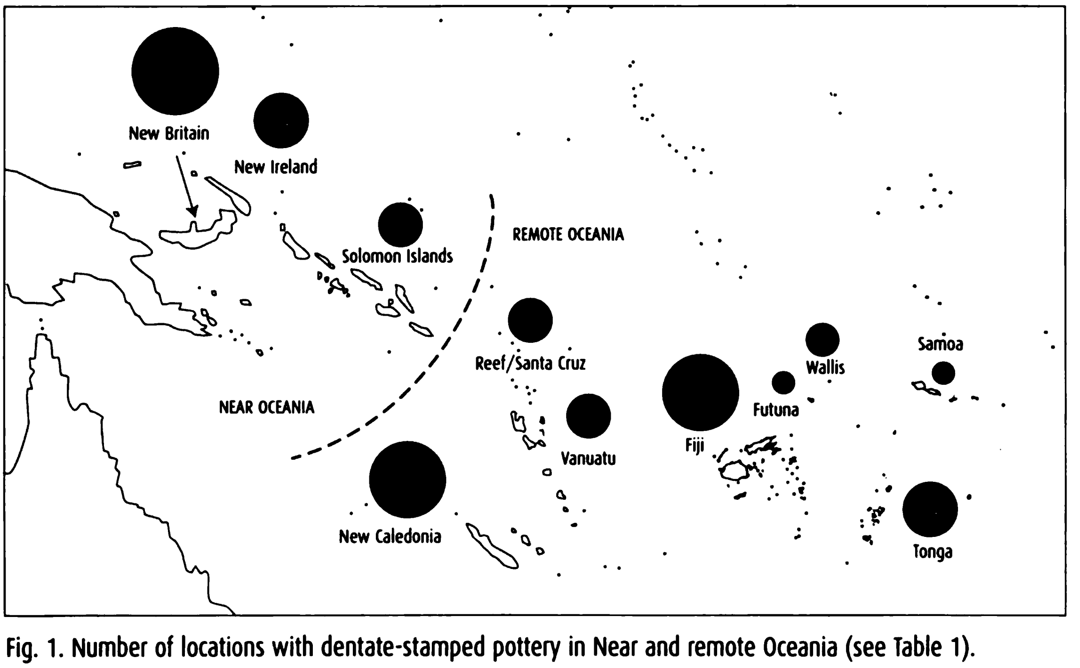

Fig. 1. Number of locations with dentate-stamped pottery in Near and remote Oceania (see Table 1).

Table 1. List of locations with dentate-stamped pottery and site characteristics.

CODE	LOCATION/ NAME	LOCALITY TYPE	EXTENT OF SITE (sq m)	CONTENTS	CERAMIC SERIES	AGE	INDICATOR REFERENCE
WEST NEW BRITAIN							
Arawes							
FNY	Paligmete	coastal midden	18,000	full range	Early	–	Summerhayes 2000a
FNZ	Winguru	coastal midden	18,000	full range	Late	–	Summerhayes 2000a
FOH	Magekur	coastal midden	10,000	full range	Early to Middle	3240–2750	Summerhayes 2000a
FOJ	Apalo	coastal midden	12,000	full range	Early to Late	3200–2520	Summerhayes 2000a
FOL	Amalut	coastal midden	3000	full range	Middle to Late	2770–2360	Specht & Gosden 1997
no code	Maklo	coastal midden	no estimate	pottery & obsidian	no estimate	–	Swadling 1992
FOR	Maklo	coastal midden	no estimate	pottery & obsidian	no estimate	–	Swadling 1992
FOF	Lolmo	offshore island cave	55	full range	Late	–	Gosden et al. 1994
FOL	Agussak	offshore island	500	pottery & obsidian	no estimate	–	Swadling 1992
Kandrian							
Kandrian area							
FLF	Alanglongromo	rock shelter	30	pottery & obsidian	Middle	3060–2750	Summerhayes 2000a
FLK	Aringilo	open site	no estimate	pottery	no estimate	–	Specht 1991a
FLX	Ngaikwo	open site	no estimate	pottery	no estimate	–	Specht 1991a
FYA	Narangpun	open site	no estimate	pottery	no estimate	–	Specht et al. 1992
Apugi Island	unknown	unknown	no estimate	pottery	no estimate	–	Specht et al. 1992
FFT	Langpun	coastal midden	no estimate	pottery	no estimate	–	Specht et al. 1981
FFS	Auraruo	coastal midden	no estimate	pottery	Middle to Late	–	Summerhayes 2000a
FNT	Kreslo (between Arawe and Kandin)	reef platform	2500	pottery	Middle to Late	–	Specht 1991b
Talasea area							
FCN	Point Mondu (east of Talasea wharf)	beach	no estimate	pottery & obsidian	no estimate	–	Specht et al. 1988
FCR/FCS	Lagenda plantation	beach	no estimate	pottery & obsidian	Early	–	Specht et al. 1988
FDK	Nariri Beach below Bitokara	beach	no estimate	pottery & obsidian	no estimate	–	Specht et al. 1988
FCH	Nabodu Beach at Bamba village	beach	no estimate	pot sherd	no estimate	–	Specht et al. 1988
FRJ	Valahia, near Pasiloke	beach	no estimate	pottery & obsidian	no estimate	–	Specht et al. 1988
FEB	Patanga village	beach	no estimate	pottery & obsidian	no estimate	–	Specht et al. 1988
FRI	Walindi	inland spur	no estimate	pottery & obsidian	no estimate	–	Specht et al. 1989
Garua Harbour							
FEA	Boduna	islet	6000	pottery & obsidian	Early to Middle	2950–2720	Summerhayes 2000a
FEM	Garala Island	offshore island	no estimate	pottery & obsidian		–	Specht et al. 1988
FQD	Langu, Binnen Island	offshore island	no estimate	pottery & obsidian		–	Specht et al. 1988
Garua Island							
FSZ	Scoria pit	coastal hill	1600	pottery & obsidian	Middle to Late	2800–2000	Summerhayes 2000a
FAO	unknown	coastal hill	1600	pottery & obsidian	Middle to Late	–	Torrence 1993
FQY	Golas Gully	coastal hill	no estimate	pottery & obsidian	no estimate	–	Torrence 1993
FAS	unknown	coastal stream bed	no estimate	pot sherd	no estimate	–	Torrence 1993
FEK	Mt America	mudflats	no estimate	pot sherd	Early	–	Torrence 1993
FRD	unknown	inland hill	no estimate	pottery & obsidian	Early to Late	–	Torrence & Stevenson 2000
FEL	unknown	coastal hill	no estimate	pottery & obsidian	Early to Late	–	Specht & Gosden 1997
FXO	unknown	coastal hill	no estimate	pottery & obsidian	Late	–	Torrence & Stevenson 2000

Table 1. continued

CODE	LOCATION/ NAME	LOCALITY TYPE	EXTENT OF SITE (sq m)	CONTENTS	CERAMIC SERIES	AGE	INDICATOR REFERENCE
FCY	unknown	beach	no estimate	pottery & obsidian	Late	–	Torrence & Stevenson 2000
FAAN/DS-7	unknown	coastal plain	no estimate	pottery & obsidian	Early to Late	2700	Torrence & Stevenson 2000
FAAJ	unknown	coastal hill	no estimate	pottery & obsidian	no estimate	–	Torrence & Stevenson 2000
FAAQ	unknown	inland hill	no estimate	pottery & obsidian	no estimate	–	Torrence & Stevenson 2000
Willaumez Peninsula							
FAAH	Numundo plantation	coastal hill	no estimate	pottery & obsidian	no estimate	–	Torrence et al. 1999
FABH	Numundo plantation	inland hill	no estimate	pottery & obsidian	Late	–	Torrence et al. 1999
FABN	Garu plantation	inland hill	no estimate	pottery & obsidian	no estimate	–	Torrence et al. 1999
Kombe							
FCL	Poi Mission	coastal midden	no estimate	pottery, obsidian, shell midden	no estimate	3000–2700	Lilley 1991
FPA	Kautaga Island	coastal midden	no estimate	full range	no estimate	3000–2700	Lilley 1991
EAST NEW BRITAIN							
Duke of Yorks							
Duke of York Island							
SDN	Piuka	coastal midden	no estimate	pottery & obsidian	no estimate	–	White & Harris 1997
SDK	Urkuk	coastal midden	no estimate	pottery	no estimate	–	White & Harris 1997
SDP	Kabilomo	coastal midden	no estimate	pottery & obsidian	no estimate	–	White & Harris 1997
SES/SET	Nakukur 1 and 2	coastal midden	75,000?	pottery & obsidian	no estimate		White & Harris 1997
Mioko							
SDQ	Mioko Island	coastal midden	no estimate	pottery	no estimate	–	White & Harris 1997
SFB/SfA	Palpal village	coastal midden	30,000	pottery	no estimate		White & Harris 1997
Kabakon							
SEE	Kabakon Island	coastal midden	8100	pottery, obsidian, bone	Early	3090	White & Harris 1997
Utuan							
SFF	unknown	coastal midden	no estimate	pottery & obsidian	no estimate	–	White & Harris 1997
Kerawara							
SEF	unknown	coastal midden	no estimate	pottery & obsidian	no estimate	–	White & Harris 1997
Makada							
SEO	unknown	coastal midden	no estimate	pottery & obsidian	no estimate	–	White & Harris 1997
SEP	Uraputput Point	coastal midden	no estimate	pottery & obsidian	no estimate	>2780	White & Harris 1997
Watom							
Reber Mission and Rakival							
SAC	Kainapirina	coastal midden	no estimate	full range	Middle to Late	2200–2000	Green & Anson 1991
SDI	Vunavaung	coastal midden	no estimate	full range	Middle to Late	2800–1800	Anson 2000
SAD	Maravot	coastal midden	no estimate	full range	Middle to Late	2300–1900	Green & Anson 2000
NEW IRELAND							
New Ireland mainland							
EFY	Lemau	coastal midden	no estimate	pottery, obsidian, volcanic stone	no estimate	–	White 1992
EAA	Lossu	coastal midden	no estimate	pottery	no estimate	–	White & Downie 1980
ELS/ELT	Lasigi (Dori & Mission)	coastal midden	no estimate	pottery	Late	2980–2690	Golson 1992
Lambon Island							
EPE	Lambon Island	unknown	no estimate	pottery	no estimate	2360–2060	Summerhayes pers. comm.
Anir Islands							
EAQ	Malekolon	coastal midden	10,000	pottery, obsidian, volcanic stone	Middle	2900–2300	Summerhayes 2000b

continued over

Table 1. continued

CODE	LOCATION/ NAME	LOCALITY TYPE	EXTENT OF SITE (sq m)	CONTENTS	CERAMIC SERIES	AGE	INDICATOR REFERENCE
ERA	Kamgot	coastal midden	100,000	full range	Early	3200–2900	Summerhayes 2000b
ERB	Mission	coastal midden	no estimate	pottery, obsidian, volcanic stone	Middle	2900–2300	Summerhayes 2000b
no code	Naliu	coastal midden	no estimate	pottery & obsidian	no estimate	2900–2300	Summerhayes 2000b
ERC	Balbalankin	coastal midden	15,000	full range	Middle	2900–2300	Summerhayes 2000b
Mussau							
ECA	Talepakemalai	coastal midden	72,500	full range	Early	3550–2770	Kirch 1997
ECB	Etakosarai	coastal midden	2700	full range	no estimate	3500–3300	Kirch et al. 1991
EHB	Etapakengaroasa	coastal midden	1150	full range	no estimate	3500–2400	Kirch et al. 1991
EKQ	Epakapaka	rock shelter	90	full range	no estimate	3100–2800	Kirch et al. 1991
MANUS							
GDN	Kohin Cave	cave	no estimate	pottery	no estimate	3900–2450	Kennedy 1981
GLT	Mouk	coastal flat	no estimate	pottery	no estimate	–	McEldowney & Ballard 1991
GFR	Paemasa (Baluan)	coastal flat	no estimate	pot sherd	no estimate	–	McEldowney & Ballard 1991
NORTH SOLOMONS							
Nissan							
DFF	Lebang Halika	rock shelter	no estimate	full range	Early	–	Spriggs 1991
DGD/2	unknown	rock shelter	40	full range	Early	>2730	Spriggs 1991
DES	Tarmon	reef flat	5110	pottery & adzes	Late	–	Spriggs 1991
Buka and Sohano							
DJQ	Kessa	reef flat	10,000	pottery, vocanic stone, adzes, obsidian	Middle	–	Wickler 2001
DAF	Sohano	reef flat	39,000	pottery, volcanic stone, adzes, obsidian	Middle	–	Wickler 2001
DAA	Sohano	rock shelter	25,000	pottery & obsidian	Middle	–	Wickler 2001
DKC	Sohano Primary School	rock shelter	100	pottery	Middle	–	Wickler 2001
SOLOMONS							
Roviana Lagoon							
no code	Honiavasa	inter-tidal	1800	pottery	Late	–	Felgate this volume
no code	Nusa Roviana	inter-tidal	no estimate	pottery	Late	–	Felgate this volume
REEF/SANTA CRUZ							
RF-2	Nenumbo, Reef Islands	coastal midden	1000	full range	Middle	3200–1900	Green 1976
RF-6	Ngamanie, Reef Islands	coastal midden	2400	pottery & midden	Middle	2800–2500	Green 1976
SZ-8	Nanggu, Nendo, Santa Cruz	coastal midden	14,000	pottery & midden	Middle	3200–3100	Green 1976
SZ-23	Malu, To Motu Neo Island, Santa Cruz	coastal midden	3000	pottery, chert, obsidian	Middle	–	McCoy & Cleghorn 1988
SZ-45	Bianga Mepala, Wia Island, Santa Cruz	coastal midden	10,000	pottery, obsidian, adze	Middle	–	McCoy & Cleghorn 1988
NEW CALEDONIA							
North coast							
NKM001	Boirra	coastal flat	10,000	full range	Early to Late	3000–2750	Galipaud 1988
NAR098	Arama	coastal flat		pottery	?Late	–	Galipaud 1988
NPI001	Pam	mangrove		pottery	?Late	–	Sand et al. 2001
West coast							
WK0027	Oundjo	coastal flat	no estimate	pottery	?Late	–	Baret et al. 2000
WK0013	Lapita	coastal flat	5000	full range	Early to Late	–	Gifford & Shutler 1956
WK0013A	Lapita	coastal flat	20,000	full range	Early to Late	3000–2750	Sand 1998a
WK0013B	Lapita	coastal flat	250	full range	Early to Late	3000–2750	Sand 1998a
WK0014	Podtanean	coastal flat	no estimate	pot sherd	?Late	–	Gifford & Shutler 1956

Table 1. continued

CODE	LOCATION/ NAME	LOCALITY TYPE	EXTENT OF SITE (sq m)	CONTENTS	CERAMIC SERIES	AGE	INDICATOR REFERENCE
WKO028	Koniene	coastal flat	no estimate	pottery	?Early to Late	–	Sand 1996
WKO141	Podtanean	coastal flat	no estimate	pottery	?Late	–	Galipaud 1988
WNP003	Franco	coastal sand	no estimate	pot sherd	?Late	–	Galipaud 1988
WNP038	Pindai	coastal sand	no estimate	pottery	?Late	–	Sand 1996
WBR001	Nessadiou	coastal sand	no estimate	full range	Early to Late	3000–2750	Sand 1996
WBR009	Ile Verte	coastal dune	no estimate	pot sherd	?Late	–	Frimigacci & Siorat 1988
WBR006	Temroc	coastal flat	no estimate	pottery	?Late	–	Frimagacci 1975
WPT055	Naïa	coastal flat	no estimate	pottery	?Late	–	Smart n.d.
WPT055	Naïa	coastal flat	no estimate	pottery	?Early to Late	–	Frimagacci 1975
WPT148	Ongoué	coastal flat	10,000	pottery	?Early to Late	–	Sand 1994
South coast							
SNA019	Anse Vata	coastal flat	no estimate	pot sherd	?Late	–	Frimagacci 1975
Ile des Pines							
KVO001	Kapume	coastal dune	no estimate	pot sherd	?Late	–	Golson 1962
KVO003	St Maurice-Vatcha	coastal dune	10,000	full range	Early to Late	2950–2700	Sand 1999
KGJ004	Gadji (1)	coastal flat	no estimate	pot sherd	?Late	–	Frimagacci 1975
East coast							
EHI050	Dowalwoue	coastal sand	no estimate	pot sherd	?Late	–	Gifford & Shutler 1956
SUN014	Witpwe	coastal flat	no estimate	pot sherd	Late	–	Sand & Ouetcho 1992
STY007	Pwekina	coastal flat	5000	pottery	Late	–	Sand & Ouetcho 1994
STY015	Goro	coastal flat	>10,000	full range	Early to Late	–	Sand et al. 2000
Loyalty Islands							
LPO020	Patho	coastal sand	>2000	full range	?Early to Late		Sémah & Galipaud 1992
LPO023	Kurin	coastal dune	>5000	full range	Early to Late	–	Sand et al. In press
LLI002	Hnaeo	coastal dune	no estimate	full range	Early to Late		Sand et al. 1998
LWT008	Hnajoisisi	rock shelter	50	full range	Late	2800–2750	Sand 1998
LWT054	Keny	coastal dune	>20,000	full range	?Early to Late	?2950–2750	Sand 1998
LUV081	Wadrilla	coastal sand	pottery	?Early to Late	–		Sand et al. 1999b
VANUATU							
Erromango							
no code	Ifo	coastal flat	500–1000	full range	?Early to Late	3000–2800	Bedford et al. 1998
no code	Ponamla	coastal flat	100–500	full range	Late		Bedford et al. 1998
Efate							
no code	Erueti	coastal flat	10–100	full range	?Early to Late	3000–2800	Spriggs 1997
Malakula							
no code	Malua Bay	coastal flat	10–100	full range	Late		Bedford et al. 1998
Malo							
MA 8-20	Batuni-Urunga	coastal flat	>3000	full range	?Early to Late	3000–2800	Hedrick n.d.
MA 8-38	Avunatari	coastal flat	>3000	full range	?Early to Late	3000–2800	Galipaud 1998
MA 8-39	Naone	coastal flat	>3000	full range	?Early to Late	3000–2800	Hedrick n.d.
MA 8-40	Atanoasao	coastal flat	no estimate	full range	?Early to Late	3000–2800	Galipaud 1998
FIJI ISLANDS							
Yasawas, Vanua Levu, Cikobia							
Y2-25	Waya, Yalobi	coastal flat	no estimate	full range	Late	2800–2400	Hunt et al. 1999
no code	Vanua Levu, Vaturekuka	riverbank	no estimate	pottery & lithics	Late	–	Parke 2000
CIK006	Cikobia, Naselala	coastal flat	no estimate	full range	Late	2800–2400	Sand et al. 1999a
Viti Levu and nearby							
VL1/1	Natunuku	coastal dune	1000	full range	Early to Late	2800–2300	Davidson et al. 1990
VL16/81	Yanuca	rock shelter	1000–3000	full range	Early to Late	–	Hunt 1980
no code	Qara-I-Oso II	inland shelter	150	pot sherd	Late	–	Anderson et al. 2000
VL15/1	Natadola Bay	coastal flat	no estimate	pot sherd	Late	–	Palmer 1966
VL16/22	Naqarai	coastal dune	no estimate	pottery	?Late	–	Hunt 1980
VL 16/1	Sigatoka	coastal dune	1000–3000	pottery & lithics	Early to Late	2850–2500	Marshall et al. 2000

continued over

Table 1. continued

CODE	LOCATION/ NAME	LOCALITY TYPE	EXTENT OF SITE (sq m)	CONTENTS	CERAMIC SERIES	AGE	INDICATOR REFERENCE
no code	Vatulele, unlocalised	unknown	no estimate	pottery	?Early	–	Ewins 1995
BQ178A	Beqa, Nadawa	coastal flat	no estimate	pottery	?Early	–	Crosby 1988
BQ175A	Beqa, Kulu	coastal flat	<1000	full range	Late	–	Anderson & Clark 1999
93A	Beqa, Melabe	coastal flat	no estimate	pottery	Late	–	Crosby 1988
BQ132	Beqa	coastal flat	no estimate	pottery	Late	–	Crosby 1988
UG1-2	Ugaga	islet	100–500	full range	Early to Late	2900–2300	Clark 1999
VL21/5	Naigani	coastal flat	1000–3000	full range	Early	2900–2700	Kay 1984
no code	Moturiki, Saulevu	islet	no estimate	pottery	Late	–	Nunn 1999
Lau Group							
no code	Yacata, Site in village	coastal flat	no estimate	pottery	Late	–	Parke 2000
no code	Susui, Bureniwaqa	coastal flat	no estimate	pottery	Late	–	Nunn & Matararaba 2000
no code	Cikobia-I-Lau, Korovusa	coastal flat	no estimate	pottery	Late	–	Nunn & Matararaba 2000
no code	Mago, Votua	coastal flat	1000–3000	full range	Late	2800–2600	Clark et al. In press
no code	Mago, Sovanibeka	rock shelter	30	pottery	Late	2700–2300	Clark & Hope 1997
101/7/197 & 101/7/96	Lakeba & Qaranipuqa -Wakea (2)	rock shelter/ coastal flat	80 + 15,000	full range	Early to Late	2900–2700	Best 1984
no code	Namuka, unlocalised	unknown	no estimate	pottery	no estimate	–	Best pers. comm.
no code	Komo, unlocalised	unknown	no estimate	pottery	no estimate	–	Best pers. comm.
no code	Moce, unlocalised (2)	unknown	no estimate	pottery	no estimate	–	Best 1984
no code	Fulaga, unlocalised	unknown	no estimate	pottery	no estimate	–	Best 1984
To31/1	Totoya, Udu	coastal flat	no estimate	pottery	Late	–	Clark & Cole 1997
To31/2	Totoya, Lawaki Levu	coastal flat	no estimate	pottery	Late	–	Clark & Cole 1997
To31/3	Totoya, Waroke	coastal flat	no estimate	pottery	Late	–	Clark & Cole 1997
no code	Ono-I-Lau (3)	coastal flat	no estimate	pottery	no estimate	–	Best 1984
TONGA							
Tongatapu (4)							
To.1/TO-Pe-11	Pe'a, Site 1	coastal flat	4300	full range	?Late	–	Poulsen 1987
To.2/TO-Nk-2	Nukuleka	coastal flat	300	full range	?Early to Late	2700–2900	Poulsen 1987
To. 3/TO-Pe-3	Ha'ateiho	coastal flat	2150	full range	Late	–	Poulsen 1987
To. 5/TO-Pe-5	Veitongo	coastal flat	1230	full range	Late	–	Poulsen 1987
To. 6/TO-Pe-6	Tufu Mahina	coastal flat	1500	full range	Late	2400–2300	Poulsen 1987
TO-Nu-82	Mangaia Mound	coastal flat	no estimate	full range	Late	3100–2600	Spennemann 1989
TO-Nu-2	unknown	unknown	no estimate	pottery	Late	–	Spennemann 1989
TO-Nu-12	unknown	unknown	no estimate	pot sherd	Late	–	Spennemann 1989
TO-Pe-28	Pe'a, Site 28	unknown	no estimate	pottery	Late	–	Spennemann 1989
TO-Pe-42	Pe'a, Site 42	unknown	no estimate	pottery	Late	–	Spennemann 1989
TO-Pe-27	Vuki's Mound	unknown	no estimate	pottery	Late	–	Groube 1971
Ha'apai Group							
no code	Tungua, Fakatafenga	coastal flat	no estimate	pottery	Late	–	Burley et al. 1999
no code	Ha'afeva, Mele Havea	islet	900	pottery	Late	2700–2600	Burley et al. 1999
no code	'Uiha, Vaipuna	coastal flat	400	pottery	Late	2800–2500	Burley et al. 1999
no code	Lifuka, Tongoleleka	coastal flat	1500	full range	Late	2800–2600	Burley et al. 1999
no code	Foa, Faleloa	coastal flat	750	full range	Late	2650–2550	Burley et al. 1999
no code	Ha'ano, Pukotala	coastal flat	1750	pottery	Late	2700–2600	Burley et al. 1999

Table 1. continued

CODE	LOCATION/ NAME	LOCALITY TYPE	EXTENT OF SITE (sq m)	CONTENTS	CERAMIC SERIES	AGE	INDICATOR REFERENCE
Niuatoputapu							
NT-90	Lolokoka	coastal flat	3000	pottery	Late	–	Kirch 1988
SAMOA							
Upolu							
no code	Mulifanua	submerged beach	6000	pottery	?Early	2750	Dickinson & Green 1998
WALLIS							
MA021	Utuleve	coastal sand	10,000	full range	Early to Late	2800–2750	Sand 1998
MA046	Utuleve	coastal flat	1000	full range	Early to Late	–	Frimigacci 2000
no code	Utupoa	coastal flat	no estimate	pottery	Late	–	Frimigacci 2000
FUTUNA							
SI001	Asipani	coastal flat	>3000	full range	Late	–	Sand 1993

(1) Unpublished surface collection

(2) One or two sites present

(3) Three sites recorded by Best (1984)

(4) see Burley et al. (2001)

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Mobility models of Lapita migration

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Introduction

What drove Lapita migration? It is perhaps the most fundamental of questions about the Lapita dispersal, and the most puzzling. It is not difficult to propose plausible answers, as Clark and Terrell (1978) demonstrated in a series of explanatory models which emphasised, variously, the skimming of high quality forage, or other opportunistic behaviour in strandlooper and supertramp models, the importance of exchange and associated interaction in a trader model, and density dependence in a population growth model. Green (1982) took issue with these on various grounds, noting that some variables were essentially common across the range, that the data on which variable states were erected were often arguable or impressionistic and so on, but he entered into the spirit of the exercise by adding a coloniser model which emphasised maritime skill and long-distance communication. Yet, in the 20 years that have elapsed since these propositions were advanced, it has not been possible to show good cause why any of those, or any other, explanations should be preferred or discarded definitively. The informal consensus seems to be that each might eventually become integrated to a greater or lesser degree into a broad general explanation.

This is not a satisfactory state of affairs and we need to consider alternative approaches. One that might help to loosen the conceptual logjam is to begin from a consideration of the most fundamental quality of migration, which is mobility. Thinking about relative mobility in Lapita dispersal and its implications for migration is analogous to the approach advocated by Groube (1967), in a prescient review of culture change models in New Zealand prehistory. Groube argued that rather than concentrating only upon the construction of serial culture stages, to which change is merely interstitial, we should also focus on change itself, tracking variations in the pattern, and modelling explanations from curves of different rates of change. His suggestion was not taken up to any significant extent in New Zealand, but it might now be possible to co-opt it into the Lapita problem, given that databases of site distribution, contents and chronology have begun to reach the stage where regional questions about rates of change and the factors that are driving them can be plausibly attempted. To a necessary concern for the meaning of relative similarity in dispersed archaeological data, which has been the ceramicist preoccupation, we might add investigation of meaning in the different rates of mobility by which the articles they represent became dispersed.

Research on mobility, generally and in terms of its particular qualities — speed, frequency, and distance and direction of movement — has a substantial archaeological history in characterising critical differences between modes of subsistence and settlement pattern, and to some extent also in defining the types and motives of migratory and colonising activities (Anthony 1990), most notably in explaining episodes of agricultural expansion (e.g. Ammerman and Cavalli-Sforza 1984; van Andel and Runnels 1995) and continental colonisation (e.g. Steele et al. 1998) but also in cases of oceanic colonisation (Irwin 1992; Keegan 1995; Keegan and Diamond 1987; Terrell 1986, and various papers in Cherry 1995). I outline here some data about differences in rates of Lapita dispersal mobility, and discuss the potential implications.

Measuring mobility

While average rates of dispersal are simple to calculate they have limited comparative utility and current conclusions are dubious. Kirch (1997:62) estimated the average rate of Lapita dispersal as 9–15 km per year for Lapita, and suggested that this "was one of the most rapid of such events known in world history". In fact, both of the other extensive maritime migrations which are reasonably well documented occurred rather faster than the Lapita expansion; the Norse colonisation of the North Atlantic (15–20 km per year) and the East Polynesian colonisation (about 30 km per year, for a 500-year episode). However, the figures are trivial. More important, as Kirch recognised, is the potential demographic implication of all rapid dispersals, a point discussed further below.

It is internal variation in dispersal rates, not the averages, which is of most potential value in investigation of migratory behaviour. Simple propositions about the rate of dispersal within colonisation episodes — measured here as the frequency with which new colonies were established — can be considered. Did the rate of dispersal decline with distance or time, increase or remain more or less even throughout? The quality of data now available allows us to investigate variations in the rate of dispersal within the Lapita expansion.

The new chronological reviews are especially valuable. The 1997 Specht and Gosden paper on the Bismarcks Lapita chronology, not only clarified the situation for that region, but also prompted similar consideration of New Caledonia (Sand 1977, 1999), Fiji (Anderson and Clark 1999) and Tonga (Burley et al. 1999). There are some problems remaining — for example, how Lapita is defined between provinces and archipelagos, and therefore how many Lapita sites there are currently recorded (see Anderson et al. this volume), but out of these papers the overall shape of the space-time framework of Lapita culture has become, for the first time with reasonably large databases, regionally differentiated, broadly accessible and generally agreed.

Spatial pattern

The spatial or distributional aspect of Lapita sites is the less satisfactory of the parameters. It is very hard to judge whether current patterns of site distribution are likely to be representative of Lapita-age distribution, and in some cases such as Samoa, they almost certainly are not (Dickinson and Green 1998). However, the broad pattern of current distributional data has remained much the same for more than 20 years, suggesting that it is not just on grounds of relative site recording intensity that the density of sites on the coasts of large islands is lower than on small islands throughout the Lapita range, or that mainland New Guinea, and perhaps the main Solomon Islands, are largely bereft of Lapita sites (especially early Lapita sites). Nevertheless, the data from the main Solomon islands have been discarded here, since this large archipelago is the least known within the Lapita distribution and current data — substantial land area versus few sites (see Anderson et al. this volume) — would skew the results of analysis disproportionately in favour of the argument advanced in this paper. For present purposes it can be accepted either that the archaeological patterning is approximately representative, or that proposition may be taken simply as a working assumption.

The number of Lapita sites, here defined as sites containing dentate-stamped pottery, is shown in Anderson et al. (this volume) and Table 1. The total numbers should be regarded as approximate since, in some cases, they vary widely between authorities — e.g. on Malo, in Vanuatu, where figures of five to nineteen sites, plus several others discovered recently, are given (Bedford pers. comm.). Counting clusters of sites, or individual islands with sites, would be another way of measuring the spatial distribution, but initial exploration of this approach showed that the results would be very similar to using individual site data. The data could also be calibrated for variation in site extent, or for some measure of contents density or diversity. The number of sites along lines of dispersal or in a matrix of least distance between archipelagos, or some statistical combination of distributional characteristics would also be possible.

Here, however, the most simple approach is taken. Variations in site frequency have been standardised by using the data for land area. A more useful measure in the case of Lapita sites might be coastline length, but in the absence of sufficiently precise data about that, land area will have to stand as a proxy measure. The results show that Lapita site density is almost exactly the same between Near and Remote Oceania, but that within Remote Oceania density increases towards the east (Table 1).

Table 1. Number of Lapita sites in Near Oceania and Remote Oceania and within the latter standardised for total land area and time span (two estimates, see text).

	NO. OF SITES	LAND AREA 1000 KM^2	SITES PER 1000 KM^2	TIME SPAN (YEARS)	SITES PER 100 YEARS
Near Oceania	87	50	1.74	1300 (900)	6.7 (9.7)
Remote Oceania	95	56	1.69	600 (400)	15.8 (23.8)
Vanuatu & New Caledonia	41	33	1.24	300 (200)	13.7 (20.5)
Fiji & West Polynesia	54	22	2.45	250 (200)	21.6 (27.0)

Chronological pattern

The chronological pattern is based on fairly standardised credentials for accepting radiocarbon determinations and calibrating the results. In Fig. 1 two sets of data are shown. First, the rectangular boxes show the chronological span according to median intercepts of calibrated radiocarbon ages. For the Bismarcks, Specht and Gosden (1997) and Summerhayes (2000, n.d.) see Lapita pottery beginning at about 3300 BP and ceasing by about 2400–2200 BP. Torrence and Stevenson (2000) argue for a more protracted decline on Garua Island, with dentate-stamped pottery production continuing until at least 2000 BP, perhaps followed by curation of decorated Lapita vessels. The Watom data might also suggest production later than 2000 BP (Green and Anson 2000). I have taken a range of 3300–2000 BP. In the Reefs/Santa Cruz, Green's (1991) calibrated ages show a range of about 3100–2600 BP. Following more recent analyses, not yet published, Green (pers. comm.) thinks that SZ8, the earliest site according to its contents, still dates to about 3100–3000 BP. Lapita sites in Vanuatu span approximately 3000–2700 BP or slightly later (Bedford et al. 1998; Spriggs 1997), and Sand (1997, 1999, 2000) suggests about 3000–2700 BP for New Caledonia. The Fijian data span 2900–2600 BP (Anderson and Clark 1999) and those for West Polynesia (Burley 1998; Burley et al. 1999) about 2850–2650 BP.

In most cases, however, regional specialists believe the radiocarbon date ranges are broader than the actual Lapita settlement periods. Summerhayes (pers. comm.) regards the upper end of the Bismarcks Lapita chronology as still uncertain but thinks that production of dentate-stamped pottery probably ceased in the period 2400–2200 BP. Sand (1999:320) suggests "a few hundred years" for Lapita tenure in New Caledonia and a span of one to two centuries has been conjectured for Fiji (Anderson and Clark 1999:37) and West Polynesia (Burley et al. 1999:66). The shaded bands in Fig. 1 describe approximately these narrower age ranges at plus/minus 50 years.

Two features of these data are important. First, the flattening curve of initial establishment suggests that there was an acceleration in the eastward expansion of colonisation. Secondly, the

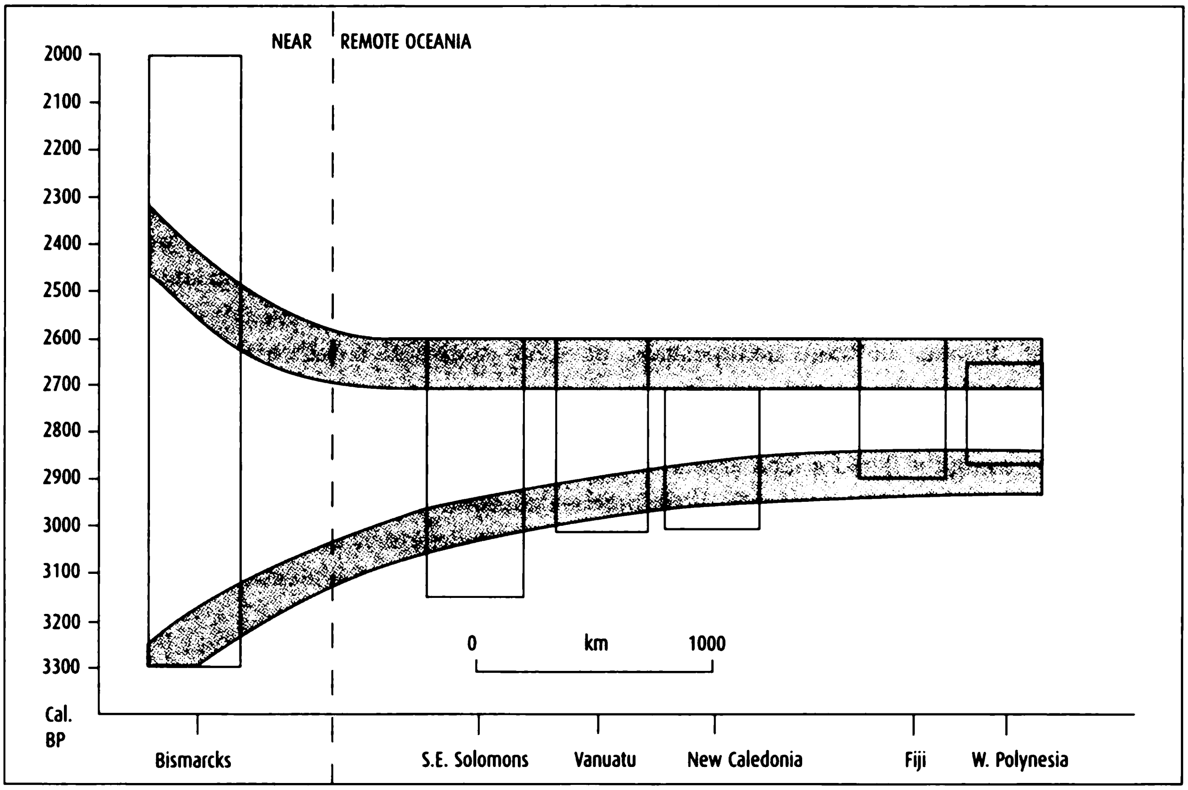

Fig. 1. Lapita age ranges and dispersal.

narrowing span of Lapita tenure eastward suggests that the colonising pulse was weakening. Lapita habitation throve, it seems, more or less in proportion to its proximity to the source whether because of greater numbers of colonists towards the west, or through more frequent communication. But whatever the reasons, they are not reflected in greater site density in the west and this has an obvious implication.

If site numbers are standardised for variation in chronology, then the rate of site establishment increased substantially between Near and Remote Oceania and within Remote Oceania (Table 1, Fig. 2). On current data, 6–10 new sites were established each century in Near Oceania, compared with 16–24 per century in Remote Oceania, where the figures rise to 22–27 sites per century in the eastern archipelagos. In other words, the pace of settlement expansion in Remote Oceania, as measured by the frequency of new sites, was twice or more that in Near Oceania. Of course, the intra-Lapita variation could be overturned if Remote Oceanic site numbers remained static while Near Oceanic site numbers doubled, or if the chronological span of the latter was more than halved. Such revisions could happen, but perhaps not very easily since new sites are still being found throughout the Lapita range.

Possible implications

At least four interesting implications may be drawn from the analytical results, skeletal as they are. First, while contrasting models do not easily capture the essence of a variation that in reality may have been clinal, or at a fine-scale episodic, Lapita migration mobility at a broad level appears to describe a binary-state or dual-phase process. This is very typical of migratory behaviour generally, both amongst animals and people. It has a stable phase which is relatively sedentary, followed by an unstable phase of high mobility. These two states can be characterised, approximately and in terms of the earlier models, as a Near Oceanic phase corresponding essentially to the population growth model, and a Remote Oceanic phase corresponding to the strandlooper model or something rather similar to it (Table 2). We

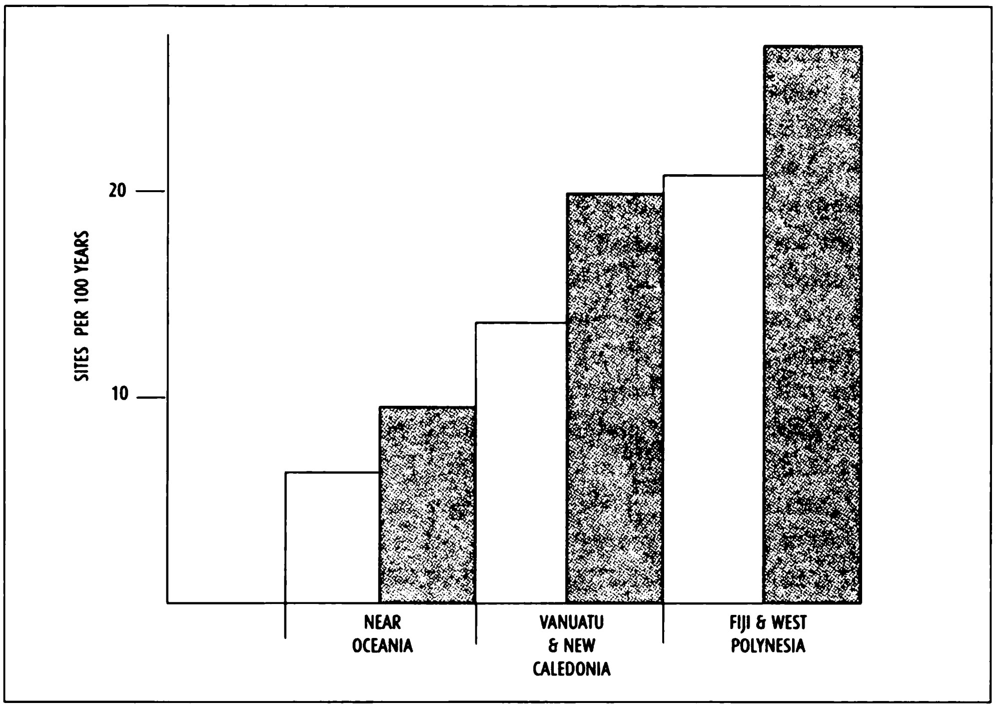

Fig. 2. Rate of Lapita site establishment per 100 years. Shaded bars use the shorter estimated age ranges. Data in Table 1.

can no longer compress migration process across the Lapita range into only one of the older descriptive models, without losing the substantial and important variation that exists within it.

Second, implicit in this line of thought is a demographic argument to the effect that in the earlier, stable, phase total population had grown or aggregated (again we must not forget the non-Lapita population), past the point of initial colonising pressure, and dispersal was favoured as settlement approached some significant measure of carrying capacity. Conversely, in the later, unstable, phase, dispersal occurred typically at the first indication of resource pressure. These are the K-type and A-type respectively (Fig. 3) of colonisation modes defined by Keegan (1995). Consequently, contrary to an assumption that Lapita population growth was insignificantly involved in colonisation process, it may have been quite influential, but in a more variable manner than is generally envisaged. However, it is not clear yet whether the faster (and possibly accelerating) rate of settlement establishment towards the east represents a higher rate of natural increase in the human population, faster fragmentation of the colonising population or a different pattern of settlement mobility. If the population growth rate was increasing, then migration might have continued without a break beyond the Lapita stage, temporally and geographically. If a greater rate of dispersal and, or, different mobility behaviours were driven by other factors, such as rapid resource depression on smaller islands, then the settlement extinction rate was probably also high. These are matters for further research, including by ecological modelling of consumption levels at which resource pressure might first become apparent, and of potential levels of carrying capacity.

Third, Lapita settlement and social patterns must have been significantly different between the phases. In Near Oceania, settlements were relatively further apart and more stable. Community fission occurred at intervals of 10–15 years. This might suggest the common development of villages with high frequencies and diversity of material culture, including exotic items, reflecting relatively stable patterns of communication and exchange. Of course, Lapita was only one of the contemporary cultures, so patterning of communication and exchange was in any case more complex. In addition, Lapita migrants entered an acculturated landscape already depleted of big or easy game (Allen et al. 1999) and in which some compensatory faunal translocation was occurring (Flannery and White 1991). Initial social and ecological conditions were, therefore, quite different to those encountered when the Lapita migration moved into its later, highly mobile, phase in Remote Oceania. There, communities dispersed on average

Table 2. Characteristics of Near Oceanic and Remote Oceanic colonising episodes.

	NEAR OCEANIA *CF. POPULATION GROWTH MODEL*	REMOTE OCEANIA *CF. STRANDLOOPER MODEL*
DESCRIPTIVE VARIABLES		
Geographic range	restricted	widespread
Duration in generations	long	short
Variability	heterogeneous	relatively homogeneous
RATE VARIABLES		
Rate of dispersal	slow	fast
Rate of extinction	slow	rapid
Rate of interaction	frequent	infrequent
CAUSAL VARIABLES		
Subsistence strategy	generalised	specialised
Reproductive strategy	?regulated	?unregulated
Dispersal strategy	?deliberate	non-strategic
Colonisation (Settlement)	effective	less effective

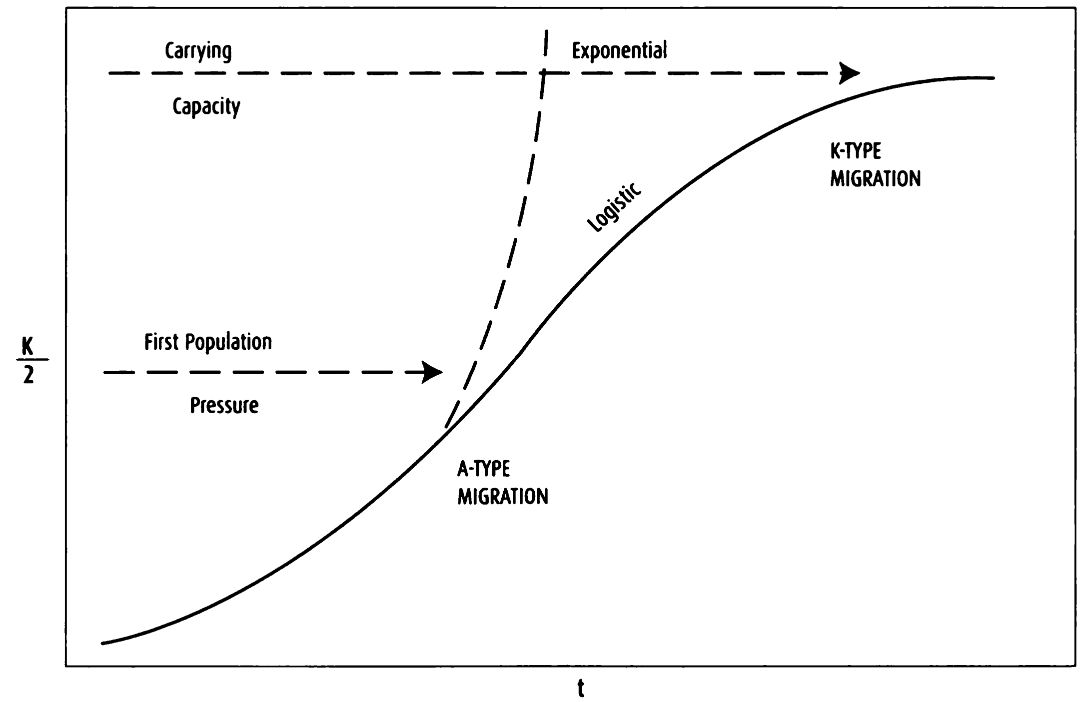

Fig. 3. Population growth curves (modified after Keegan 1995:Figure 2). K = carrying capacity, t = time.

at intervals of 4–6 years, into unexploited environments. To what extent there was agriculture remains uncertain, but at least in the eastern archipelagos there is a strong suspicion that it was rudimentary at best until some time after the initial expansion (Clark and Anderson In press). In these conditions we might expect smaller, less formal settlements and evidence of only rudimentary systems of exchange, leading in turn, perhaps, to rapid fragmentation of colonising patterns of material culture.

The evidence of a generic coherence in material culture across the Lapita range may be lulling us, then, into a false sense of similarity about other aspects of Lapita prehistory, such as subsistence patterns, ecological relationships, and social structures. Such evidence as may be brought to bear on this matter does suggest that there was a regional difference. For example, site extent estimates (Anderson et al. this volume), though necessarily rather imprecise, show that half (14 of 30 sites with estimates) of the Near Oceanic Lapita sites were 10,000 sq m or greater in extent, compared to one-fifth (10 of 49 sites with estimates) in Remote Oceania. In addition, remains of substantial structures are confined to Lapita sites in Near Oceania, and individual sites there often have sequences indicative of longer tenure and more diverse remains suggestive of more intensive interaction (Summerhayes 2000).

Last, regional variation in migratory behaviour during the Lapita period invites conjecture as to whether this is only one case in a progression of cyclic variation in mobility (in Groube's 1967 terms a multi-strophic model) which, at a certain level, would offer us a theoretical underpinning to the empirical consensus that Pacific colonisation was episodic or punctuated (e.g. Green 1997 and earlier, *contra* Irwin 1992). Looking back to the Austronesian expansion we see stable settlement in New Zealand preceded by rapid over-expansion into the outlying archipelagos, preceded by several hundred years of settlement stability in East Polynesia that had followed, in turn, a phase of rapid and far-reaching migration (Anderson 2000a). Before that, we had a long period of settlement stability in West Polynesia, preceded by the Lapita expansion and that in turn, perhaps, by an earlier cycle of expansion from the South China region (Fig. 4). Is this apparent patterning illusory or is there something important in it? Does it describe an inherent trajectory in island colonisation which is, so to speak, self-sufficient in its processes and causes and which, if all islands were the same, would display a regular pattern of binary mobility phases?

Certainly, consideration of variable mobility in colonisation raises the most difficult question amongst animal as well as human populations, which is not why episodes of migration start, but why they stop. Arguments are generally *ad hoc* and invoke propositions of a decline in colonising vigour or the reaching of an environmental barrier which was often overcome later; both of which beg the question of where the real impetus to colonisation lay. This important issue is no more mysterious than it is in the Lapita case. I have suggested elsewhere that there may have been influential climatic or maritime technological reasons involved (Anderson 2000b), but if we prefer endogenous arguments such as population pressure for the initiation of colonising episodes, then it is theoretically flabby to invoke exogenous factors such as climatic change to bring them to a halt. Better demographic and ecological modelling is required to show how, when and with what degree of probability a phase of rapid dispersal actually *requires* a subsequent phase of settlement stability.

These thoughts on mobility models in Lapita migration constitute a brief and preliminary review of the issues but raise some useful points even at this stage. If it is accepted that migration mobility changed from a largely tethered, time-transgressive pattern in the west, to a largely released and space-transgressive pattern in the east, then none of the orthodox monolithic models is sufficient to describe or explain it. And if it is accepted that Lapita was only one colonisation cycle amongst four or five in the 4000-year-long Austronesian expansion, then explanations of Lapita must also be pertinent to understanding Pacific migration in general, or demonstrate why not.

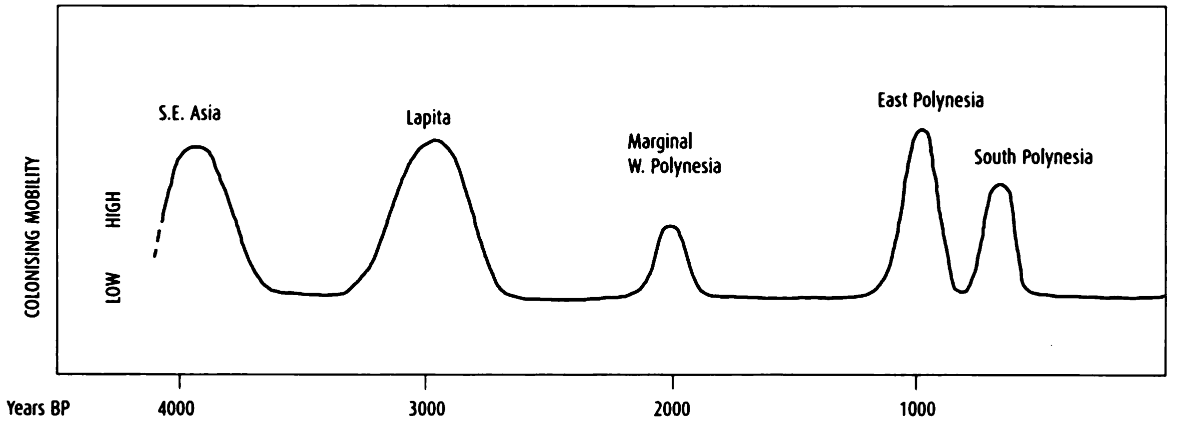

Fig. 4. Episodic pattern of relative colonising mobility in Oceania.

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Defining the chronology of Lapita in the Bismarck Archipelago

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Introduction

One of the key elements in interpreting the role of Lapita in the Bismarck Archipelago is its chronology. Of interest is not only when did it occur, but also when did changes occur in the material complex within different parts of the archipelago? Yet the lack of radiocarbon dates from key Lapita sites in the Bismarck Archipelago is hampering the placement of many assemblages into a chronological sequence and forcing archaeologists of the region to rely on ceramic stylistic analyses to discern changes over time. Only the Mussau Lapita assemblages are considered to be adequately dated. The aim of this paper is to refine the chronological framework from the Lapita sequence of the Bismarck Archipelago by presenting new radiocarbon determinations from two important Lapita assemblages in the Arawe Islands and in the Anir Island Group. Providing such a framework and resolving the chronology of the region is needed to assess not only the nature of society that produced and used these ceramics, but also the models for colonisation and interaction in the western Pacific.

Background

The importance of obtaining a more precise chronology for Lapita in the Bismarck Archipelago is seen in the models used to explain its spread. There are three main models for the Lapita colonisation of Remote Oceania.

The Fast Train Model

The first involves a movement of Austronesian-speaking people out of Southeast Asia and into Remote Oceania, who passed through the Bismarck Archipelago, carrying with them their material-culture repertoire (the Lapita Cultural Complex). Based on early radiocarbon estimates, the initial occupation of the Bismarcks was seen as pre-dating occupation in Fiji, 3000 km to the east, by a century at most (Kirch et al. 1987). This led proponents of the model to interpret the spread of Lapita colonisation as archaeologically instantaneous (see Kirch and Hunt 1988a; Kirch et al. 1987), thus accounting for the similarity in material culture over a vast region. This model considers domestic animals, the Austronesian languages of the Pacific and many elements of the material-culture kit to be derived from Southeast Asia. In this model any subsequent change in the pottery style is due to the subsequent isolation of populations.

Indigenous Bismarck Archipelago Model

The second model views the development of the Lapita Cultural Complex within the Bismarck Archipelago. That is, the colonisation of Remote Oceania has its origins in the Bismarck Archipelago, with the Lapita Cultural Complex arising from internal social and economic developments in the previous 35,000 or so years of occupation (Allen 1984; White and Allen 1980). Despite this, people did not live in a vacuum and could have had contacts with the west from which they may have acquired the skills to make pottery, seen in this model as "culturally unaccompanied baggage" (Kennedy 1983:120). As Allen noted (1991:7), "such contacts would have facilitated the flow of materials, technologies and people in both directions".

The Slow Train Model

The third model, although seeing the origin of the Lapita Cultural Complex in Southeast Asia (as in model 1), takes into account the possibility that Lapita may have been in the Bismarcks for 300 years before spreading out into Remote Oceania. Roger Green (1991) has developed a variant of this model that he calls the Triple I model: Intrusion/Innovation/Integration. Intrusion equates with Austronesian speakers coming into the area from Southeast Asia bringing with them items of material culture. Innovation equates with new developments within the Bismarck Archipelago, while Integration equates with adopting elements of material culture from the area's original inhabitants. Thus people may have paused in the Bismarcks and indeed picked up local elements of material culture on the way (Green 1991), perhaps learning to adapt "to an area with a complex continental island environment, which possessed a wide range of resources" (Green 1979:45) — a kind of 'homeland' (see also Spriggs 1989:608, 1996). Both the second and third models see the Lapita Cultural Complex as developing in the Bismarck Archipelago before colonising groups left the area for Remote Oceania.

The importance of pottery sequences

The identification of stylistic change in the Bismarck Lapita assemblages

One of the drawbacks of trying to assess the colonisation models presented above is the lack of radiocarbon dates available for the Lapita sequences of the Bismarcks. This has led archaeologists to construct stylistic sequences on pottery and to link these to the few available dates. For instance, Anson (1983, 1986) defined the 'Far Western' style based on decoration from three Lapita assemblages: 1. Talasea (FCR/RCS) on the Willaumez Peninsula, north-coast New Britain; 2. Malekolon (EAQ) on Ambitle Island, Anir, off the southeast coast of New Ireland; and 3. Eloaua (ECA) off Mussau, New Ireland Province (see Fig. 1). He also linked the 'Far Western' with two radiocarbon determinations from Egloff's excavation on Eloaua: 3900 ± 180 BP (GX 5499) and 3030 ± 180 BP (GX 5498) (Bafmatuk et al. 1980; Egloff 1975). Anson proposed that the 'Far Western' preceded the later 'Western' assemblage of Watom (SAC, SAD) off the northeast end of New Britain.

The proponents of the Indigenous Bismarck and the Slow Train models saw the 'Far Western' pottery as evidence that ceramic styles developed within the Bismarck Archipelago prior to the settlement of Remote Oceania. On the other hand adherents to the 'Out of Southeast Asia' model, such as Patrick Kirch and Terry Hunt, originally argued that this province did not exist and was defined on inadequate sampling (Kirch et al. 1987). The initial spread of Lapita should have resulted, they thought, in a uniform style across western Melanesia with any change in the pottery style the result of the subsequent isolation

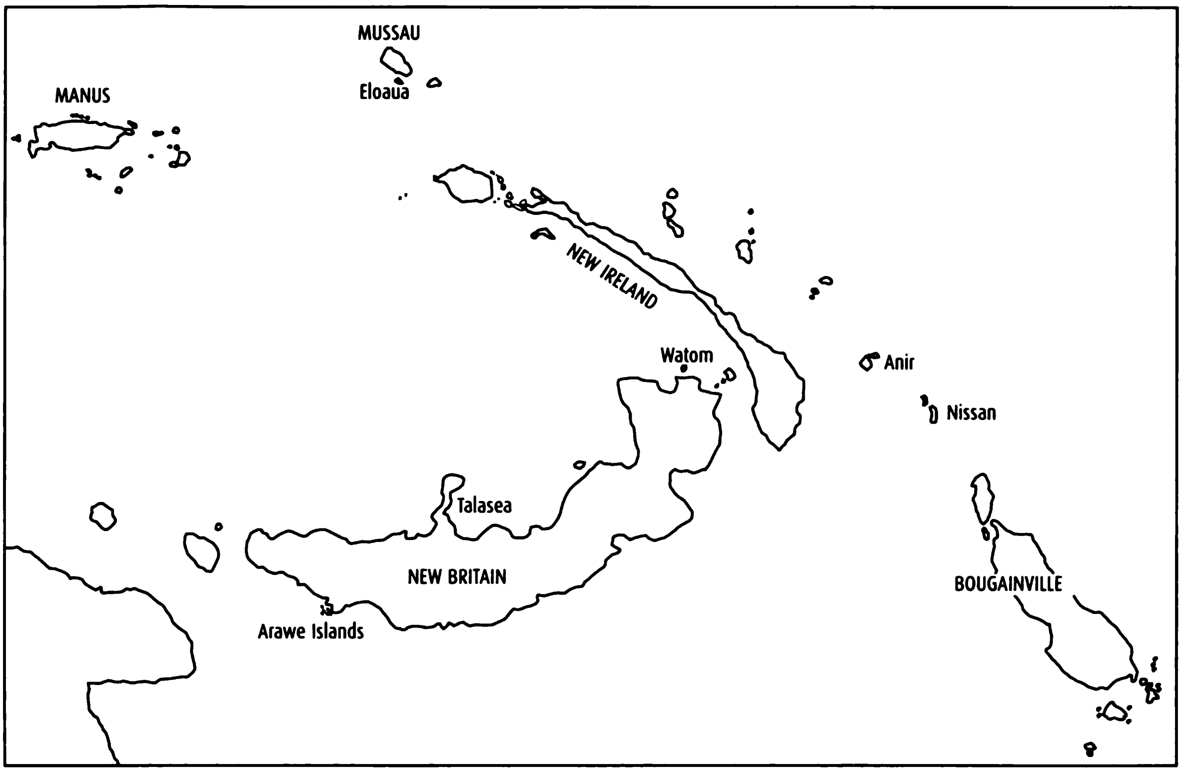

Fig. 1. Map of the Bismarck Archipelago.

of these populations. Thus, unique motifs in the Bismarcks may "signal little more than local stylistic divergence after the initial Lapita dispersal through eastern Melanesia" (Kirch et al. 1987:126). They also correctly pointed out that the 3900 ± 180 BP date from Eloaua was inconsistent with other determinations obtained by Kirch and others in this region and is way too early. Kirch and Hunt (1988b) see Lapita pottery appearing later in the Bismarcks at 3550 BP, although Specht and Gosden have made a downward revision to around 3300–3200 BP (Specht and Gosden 1997:189).

Ten years after these positions were taken the situation has changed. The redating of the settlement of New Caledonia (Sand 1997), Fiji (Anderson and Clark 1999) and Tonga (Burley et al. 1999) has shown that the initial occupation of the Bismarcks pre-dated occupation in Fiji, 3000 km to the east, by considerably more than a century even allowing for a shortening of the Bismarck data range.

Mussau

The Mussau sequences excavated by Kirch and his team confirmed the existence of an earlier Lapita occupation with ceramic stylistic features akin to what Anson had defined in the early 1980s. This recently led Kirch to redefine 'Far Western' Lapita as a regional term, with both an early and later phase (1997:287). Ceramic change over time can be seen in three areas: decoration, form and production. First, in regards to decoration Kirch et al. (1991:151) identify a change from complex intricate dentate found in the lower units of ECA, Talepakemalai, to coarser open dentate stamping which dominates in the upper zones. Also, changes in decorative types over time are noted, with linear incision increasing in the upper zones although it does not replace dentate stamping (Kirch 1988:335, Kirch 1990:Fig. 2; Kirch et al. 1991:151). Kirch identified a similar transition in Epakapaka Shelter (EKQ). There, he noted a decrease in dentate and an increase in incision over time, with appliqué found in the upper units (Kirch et al. 1991:151). Second, in regard to the vessel forms found at ECA, both bowls and pedestal stands (Kirch calls the latter pedestal feet) decline proportionally over time while jars increase (Kirch 1990:Fig. 2). Thirdly, in respect to ceramic production, there was a reduction in production centres over time (Kirch 1990:123). Kirch sees the transition between an earlier and later phase to be around 1000 BC or 2950 BP (Kirch et al. 1991:151).

Arawe Islands

Similar changes in ceramic decoration, form and production are seen in the Lapita assemblages from the Arawe Islands, southwest New Britain (see Fig. 2 for the location of sites). On the basis of both decoration and vessel form the Arawe pottery assemblages group into two:

1. Adwe (FOH) squares D/E/F and Paligmete (FNY), and
2. Apalo (FOJ) and Adwe (FOH) square G.

Both Adwe (FOH) squares D/E/F and Paligmete (FNY) group with Far Western Lapita sites from the Bismarck Archipelago, while the rest group with Western Lapita sites (see Summerhayes 2000a for further details). On the basis of a comparison of Lapita ceramic assemblages across the Western Pacific in terms of decoration, in particular dentate motifs, and vessel form, it was suggested that the changes in Lapita pottery are primarily due to temporal factors. It was recommended that the terms 'Far Western', and 'Western' should be replaced by Early and Middle Lapita (see Summerhayes 2000a, Summerhayes In press). Another phase called Late Lapita was defined to replace 'Eastern' Lapita, although this was constructed by comparing what were thought to be unique motifs found in the pottery assemblages of Fiji, Tonga and Samoa with similar motifs found in those assemblages further west in the Bismarcks (Summerhayes 2000a).

Within some of the Arawe assemblages some changes are seen. For instance, the lowest levels of Apalo contained a little pottery from Early Lapita, which was overlain by Middle Lapita pottery. Chronological changes were also seen in the Adwe squares D/E/F assemblage. These chronological differences in decoration are another indicator that Adwe squares D/E/F were earlier than both Apalo and Adwe square G. Prior to outlining these differences, a short description of the depositional history of Adwe will be given, followed by a description of the changes occurring within the assemblage.

Depositional history

The depositional history of Adwe is one influenced by the actions of humans. The site is located on a sand spit, called Makekur, projecting from the northern tip of Adwe Island. The build-up of the spit is interpreted as resulting from the accumulation or trapping of sand around stilt houses in shallow water.

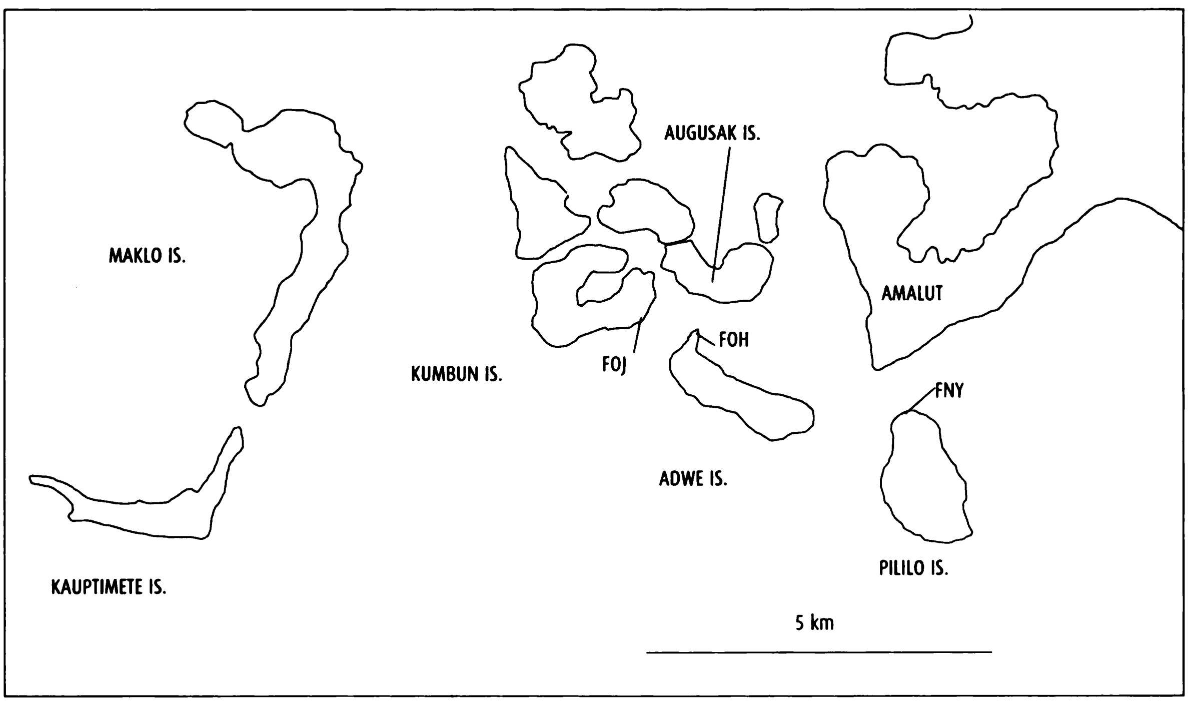

Fig. 2. Map of the Arawe Islands.

Further details are provided in Gosden and Webb (1994) and Summerhayes (2000a). Thus, initial occupation was over water in stilt houses and not on dry land, with the material deposited in a low-energy marine environment.

Sandy deposits overlie basal coral at a depth of 160–170 cm. A division can be made between two major levels found with cultural material:

1. Material within an upper partially concreted sand layer; and
2. Material below this layer in fine white unconsolidated sands.

The partly concreted sand layer is a result of the interaction of the freshwater lens with the salt water. These deposits are found in a brackish freshwater lens (Ghyben-Herzberg lens after Kirch 1988:333). This concretion was intermixed with fine, white unconsolidated sand which has formed between 90 cm and 130 cm below ground level.

Heavy concentrations of pottery and obsidian occur within the white unconsolidated sand directly over the basal coral, with the bulk of the pottery found in the bottom 35 cm. The remaining pottery was found in the bottom 10–15 cm of the overlaying partially concreted level. Above these concretions the deposit contains little cultural material, but includes two Type X sherds, a ceramic ware found on mainland New Guinea on the north coast of the Huon Peninsula, and on Tami Island, Arop Island, the Siassi Islands, and the north coast of West New Britain (Lilley 1986, 1988a, 1988b, 1991). Its origin is unknown although Lilley posits an eastern Huon Peninsula origin (Lilley 1988a:95, 1988b:514). Dating its occurrence is problematic due to disturbed deposits. Lilley, however, believes that its production began ca. 1600 BP (Lilley 1988a:96).

Although two major stratigraphic units are associated with the cultural material (white unconsolidated sand and partially concreted sand), it was decided to divide the bottom layer into four finer divisions (A–D) based on depth in order to ascertain the temporal nature of the pottery distribution (decoration, fabric, shape). This yielded five analytical units.

1. Units A, B, C and D represent the fine white unconsolidated sand layer free of concreted lumps. Unit A covers the pottery sitting on coral while Unit D underlies the partially concreted level.
2. Unit E correlates with the lower third of the partially concreted sand layer.

For the purposes of comparison with the other assemblages in Summerhayes (2000a), the pottery from Unit E was grouped with Units A, B, C and D. However, to discern changes over the ceramic sequence from Adwe squares D/E/F the units will be presented in three: A–C, D and E (see Tables 1 and 2). Apalo will be described in its original layers.

Changes in the ceramic sequence

Within Adwe squares D/E/F differences are seen in both decoration and vessel form between the major Units A–C, D and E (see Tables 1 and 2). The percentage of decorated sherds decreases from 6% to 5% in the bottom of the site to 3% in Unit E (Summerhayes 2000a:44). Based on the number of decorated sherds, the assemblage from Adwe squares D/E/F is dominated by dentate decoration. Yet changes occur, with the proportion of dentate decoration declining gradually over time, until in Unit E notched rims increase in percentage and linear-incised decoration dominates. This relates to changes in vessel form. Where the bulk of the Adwe squares D/E/F assemblage in Units A–D was characterised as a bowl and jar assemblage, the upper Unit E is a jar-only assemblage. This change occurs in conjunction with a dramatic decline in sherd numbers, and possible changes in the depositional regime, such that deposition was no longer over water.

How do these changes relate to other assemblages? The upper cultural unit from Adwe squares D/E/F, Unit E, is similar to those cultural units from the later Middle Lapita assemblages of Adwe square G and the top three layers of Apalo, where linear incision is the dominant form of decoration over dentate. Unit E is also similar to the Middle Lapita assemblage of Adwe square G and Apalo in terms of vessel form. This fits in with the trend of a decreasing proportion of bowls from the Early Lapita to later Lapita assemblages. Thus, within Adwe squares D/E/F there is a change from Early Lapita ceramics in the lower levels to a later Middle Lapita assemblage in the upper Unit E.

Table 1. The percentage of major forms of decoration in the Arawe assemblages per unit.

SITE CODE	FNY	FOH/DEF	FOH/DEF	FOH/DEF	FOH/G	FOJ	FOJ	FOJ	FOJ
Unit/Level		A-C	D	E	Level 4	D	C	B	A
Dentate	70	72	43	33	28	36	26	20	9
Linear incised	4	5	16	39	37	29	28	46	20
Misc. incised	8	4	2	0	16	14	22	24	24
Notched rim	9	7	14	17	10	14	19	13	20
Scalloped rim	0	2	4	0	0	0	0	5	5
Cut lip	1	7	8	5	11	7	8	1	2
Grooved/channelled	0.5	1	4	17	6	0	0	0	2
Fingernail impressed	0.5	3	10	0	1	0	0	1	7

Table 2. The percentage of vessel forms in the Arawe assemblages per unit.

SITE	FNY	FOH/DEF	FOH/DEF	FOH/DEF	FOH/G	FOH	FOJ	FOJ	FOJFOJ
Unit/Level Vessel Form		A-C	D	E	Level 4	D	C	B	A
I — bowls	32	24	13	9	6	0	16	9	18
II — vertical walled vessel	10	8	4	9	2	50	30	3	9
III — everted horizontal rim	7	4	13	9	2	0	7	6	0
IV — restricted neck and flat horizontal rim	7	5	0	9	2	0	4	0	0
V — carinated jar with outcurving neck	21	31	50	36	63	50	33	74	54
VI — everted round bodied pots	6	15	8	9	18	0	0	0	9
VII — conical restricted upper vessel form	6	4	13	9	2	0	7	6	9
VIII — stands	11	9	0	9	6	0	2	3	0

Thus, without radiocarbon determinations it could be argued that based on comparisons with the Mussau assemblages and the changes that are seen within the Adwe squares D/E/F assemblage and their relationship with Apalo and Adwe square G, Adwe squares D/E/F were earlier than both Adwe square G and Apalo. These changes within both the Arawe and Mussau assemblages are seen not only in types of decoration and vessel form, but also in changes to the types of dentate-stamped motifs and in production, with a reduction in the number of pottery-producing centres in both areas over time. Many of the motifs that occur on the later Lapita wares from the region are not found on the earlier dentate-stamped vessels.

Anir

Similar changes are also seen in the assemblages from Anir, New Ireland. Although a full analysis of the ceramics has not been completed as yet, preliminary results agree with the Mussau and Arawe ceramic sequences (see Summerhayes 2000b). It is argued that the Anir Lapita assemblages can also be divided into two groups on the basis of pot decoration technique, motifs and vessel form. The first, comprising Early Lapita, contains the assemblage from Kamgot (ERA) on Babase Island. The second group comprises assemblages located on Ambitle Island (the Mission ERG, Balbalankin ERC and Malekolon EAQ) which all have a low percentage of dentate decoration on a par with the Middle (Western) Lapita (see Summerhayes 2000b for a detailed discussion, and Fig. 3 for the location of sites). Further differences between these two groups can also be seen in terms of production, with the later Middle Lapita sites having less fabric variability than Kamgot (Summerhayes 2000b). The Mission site (ERG), however, may be later (Middle/Late Lapita) as from a cursory examination the dentate decoration is more open and loose. It is also found with linear incision, applied bands and flat knobs.

Another indicator that Kamgot is earlier than the other Anir sites can be seen in the proportion of obsidian obtained from west New Britain or Admiralty sources. It has been argued (Summerhayes 2000b) that the proportion of obsidian from different sources within sites in eastern New Britain, New Ireland and Mussau (away from the source areas) can be used as a rough temporal indicator. Sites at some distance from the obsidian sources have a mixture of both Admiralty and Willaumez Peninsula obsidian. The proportion is dependent not only on closeness to the source, but also on the nature of social distance between those communities within the exchange network (see Green 1987). Changes in the proportion of obsidian over time thus represent the changing nature of social distance between those communities providing obsidian from the source, either directly or as part of exchange links. Mussau, for instance, is much closer to the Admiralties than it is to the Willaumez Peninsula (see Fig. 1). If nearness to the source were the only factor, then the Mussau assemblages would have contained an overwhelming percentage of Admiralty obsidian. Yet this is not the case. In its earliest Lapita levels (sites ECA and EKQ), obsidians from both the Admiralties and the Willaumez Peninsula are found in equal number. Over time, though, Admiralty obsidian dominates and the Willaumez Peninsula obsidian declines (see Kirch 1990).

The sites from Anir follow a similar pattern to that of Mussau, although differences are seen. Here the Early Lapita site of Kamgot has predominantly Willaumez Peninsula obsidian (80%), while the Middle Lapita sites have varying proportions. Malekolon and Balbalankin obsidians are predominantly Admiralty obsidian (64% and 67% respectively). The Mission falls in between, with 56% from west New Britain and 44% from the Admiralties (Summerhayes 2000b). Sites close to the Willaumez Peninsula sources, on the other hand, have no Admiralty obsidian, and only three pieces were found in the Arawe assemblage (Summerhayes et al. 1998). Sites in between, such as the Duke of Yorks and Watom, have varying mixtures, indicating changing exchange links with the source areas (Green and Anson 1991; White and Harris 1997). Later sites on New Ireland, however, are dominated by Admiralty obsidian.

These results confirm a change from an east-west to a north-south obsidian distribution network over time. Like Mussau, Willaumez Peninsula obsidian is found in contexts with Early Lapita pottery, while the proportion of Admiralty obsidian increases over time.

Lack of dates

These developments in the ceramic sequences suggest that the Lapita Cultural Complex developed within the Bismarck Archipelago. Yet, instead of supporting an indigenous model for Lapita, they

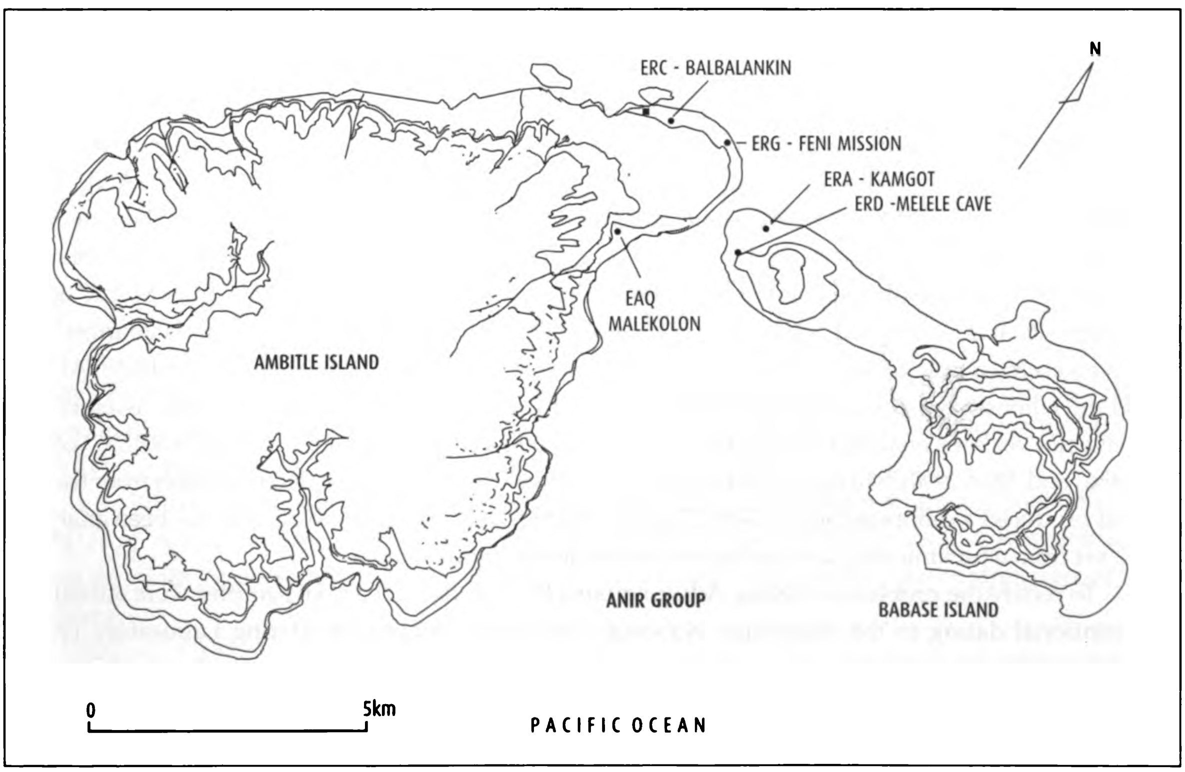

Fig. 3. Map of the Anir Island Group.

support the 'Slow Train' model and Green's Triple I model. What these developments have shown is that similar changes in pottery form and decoration occur at different prehistoric settlements located at the extremes of the Bismarck Archipelago (the Arawe Islands, Mussau and Anir), and are also seen in other sites such as Talasea, Boduna, Garua and Watom.

As seen above, this is based on an independent analysis of the Arawe and Anir ceramic assemblages, and on a comparison with Kirch's analysis from Mussau. What were lacking, though, in the Arawe and Anir record were radiocarbon determinations.

Dating the Arawe Islands and Anir ceramic sequence

All dates presented here are ^{13}C corrected and calibrated using Calib 4.1.2 (Stuiver and Reimer 1993). A laboratory multiplier value of K=1.0 was used. Carbon samples were calibrated using the atmospheric decadal data set while shell samples used the marine calibration data. The latter used a "time-dependent global ocean reservoir correction of 402 years" (Stuiver and Reimer 1993:1.3.4). This is a different procedure from that used by Specht and Gosden (1997:177) who calibrated their marine samples using the atmospheric decadal data set with an Oceanic Reservoir effect value of –400 years. Because of this difference in methods, all marine dates listed in Table 3, which were previously presented in Specht and Gosden (1997), have been recalibrated using the specifications outlined above.

Arawe Islands

Prior to this study only one radiocarbon estimate was available from Adwe D/E/F and it had a conventional age of 2800 ± 70 BP (Beta 55323) (Specht and Gosden 1997:Appendix 1), which when calibrated becomes 2730(2530)2260 cal BP. This date did not fit the expected pattern and was regarded as unreliable (Summerhayes 2000a:27). This date was younger than most of the Middle Lapita assemblages, let alone Early Lapita, and would have been expected from Unit E rather than Units A–C. Unfortunately it was the only radiocarbon age estimate available until now from this important assemblage.

Ten other radiocarbon estimates were available from the Arawes in association with Lapita pottery (Adwe square G/H Beta 37561, Beta 54164; Adwe Test pit 1 (TP 1) Beta 27946; Adwe TP 21B Beta 54165, Beta 54166; Adwe TP 28 Beta 55456; Apalo Beta 29244, Beta 29245; Paligmete Beta 27940; Amalut Beta 54168 — see Table 3). A couple of these estimates warrant closer inspection. First, a date of 2760(2690)2390 cal BP (Beta 27940) from Paligmete, FNY, came from the bottom of a sticky brown clay layer containing Lapita pottery that has evidence of disturbance and redeposition from storm action (a lens of sterile white sand). From the top of this layer two other radiocarbon estimates give ages of 1291(1048, 1033, 988)737 cal BP (ANU 4989) and 1414(1058)671 cal BP (ANU 4990) (Gosden and Webb 1994:44; Summerhayes 2000a:25). The date from the bottom of this layer should be treated with caution. Secondly, two radiocarbon estimates were obtained from Adwe TP 21, an assemblage that has not been analysed in detail. The first sample, from Spit 17 at the bottom of the site, has a calibrated age of 2970(2840, 2830, 2790)2750 cal BP (Beta 54166). This is younger than a sample taken from Spit 13, 40 cm above, which is dated at 3240(2950)2780 cal BP (Beta 54165). At two standard deviations the dates are indistinguishable. Thirdly, determinations from two Adwe assemblages which have not yet been analysed, TP 28 and TP 1, have produced calibrated ages of 2740(2660)2360 cal BP (Beta 55456) and 3210(2990)2810 cal BP (Beta 27946) respectively. Lastly, a single determination from the site of Amalut produced a calibrated age of 2780(2710)2360 (Beta 54168). The assemblage has not been analysed in detail, yet from a preliminary examination the pottery looks Middle Lapita.

To rectify the problem of dating Adwe squares D/E/F, three charcoal samples were submitted for conventional dating to the Australian National University Quaternary Dating Laboratory (ANU 11186, ANU 11187, ANU 11192), and two charcoal samples (Wk 8539, Wk 8540) were submitted for AMS dating to the Waikato Radiocarbon Dating Laboratory. Three of the samples (ANU 11186, ANU 11187, Wk 8539) came from the bottom of the deposit (Units A and B), while one (Wk 8540) came from the top of Unit E, and another (ANU 11192) from the transition between Unit E and the layer above.

Table 3. Radiocarbon estimates from the Arawes and Anir.

	LAB. CODE	SITE	TEST PIT	SPIT	AGE BP	CALIBRATED AGE 2 STD
REJECTED						
Charcoal	Wk 8539	FOH	F1	9	3740 ± 60	4280 (4090) 3910
EARLY LAPITA						
Arawe						
Shell	Beta 55323	FOH	D1	10	3230 ± 70	3240 (3040) 2850
Shell	Beta 29245	FOJ	03	17	3230 ± 50	3200 (3040) 2890
Charcoal	ANU 11187	FOH	D3	9	2730 ± 100	3140 (2840,2830,2790) 2720
Charcoal	ANU 11186	FOH	E2	9	2800 ± 110	3240 (2920,2910,2880) 2750
Shell	Beta 27940	FNY	TP 1	13	2870 ± 70	2760 (2690) 2390
Shell	Beta 27946	FOH	TP 1	11	3200 ± 70	3210 (2990) 2810
Anir						
Charcoal AMS	Wk 7561	ERA	1	6	3035 ± 45	3360 (3320,3320,3250,3220,3220) 3080
Charcoal AMS	Wk 7563	ERA	1	9	3075 ± 45	3380 (3330,3290,3270) 3080
Shell	Wk 7560	ERA	1	6	3260 ± 45	3210 (3080) 2950
Shell	Wk 7562	ERA	1	9	3350 ± 45	3330 (3210) 3070
Shell AMS	Wk 7558	ERD	1B	20	3245 ± 45	3200 (3060) 2930
Charcoal AMS	Wk 7564	ERA	1	11	2765 ± 50	2960 (2850) 2760
MIDDLE TO LATE LAPITA						
Arawe						
Shell	Beta 37561	FOH	G	6	2860 ± 70	2760 (2680) 2360
Charcoal	Beta 54164	FOH	G	13	2640 ± 90	2920 (2750) 2480
Charcoal	Beta 54165	FOH	TP21B	13	2850 ± 80	3240 (2950) 2780
Charcoal	Beta 54166	FOH	TP21B	17	2730 ± 70	2970 (2840,2830,2790) 2750
Charcoal	Beta 54168	FOL	TP 4	17	2530 ± 70	2780 (2710) 2360
Shell	Beta 55456	FOH	TP 28	14	2840 ± 60	2740 (2660) 2360
Shell	Beta 29244	FOJ	03	13	2960 ± 80	2880 (2740) 2520
Anir						
Charcoal	ANU 11193	EAQ	4	11	3220 ± 170	3830 (3440,3430,3400) 2960
Charcoal	ANU 11190	EAQ	4	10	2110 ± 240	2750 (2110,2080,2070) 1530
Charcoal	ANU 11188	ERC	1	5	2620 ± 110	2950 (2750) 2360
Shell	WK 7556	ERD	1	14	2810 ± 50	2710 (2560,2550) 2350
Charcoal	Wk 7557	ERD	1a	14	2400 ± 80	2740 (2360) 2210
Charcoal	ANU 11191	ERG	1	6	3090 ± 170	3690 (3340,3280,3270) 2850
LATE LAPITA						
Charcoal	Wk 8540	FOH	E2	4	2060 ± 60	2300 (2000) 1880
Charcoal	ANU 11192	FOH	D3	3	1350 ± 160	1560 (1290) 930

Of the three determinations from Units A and B, one is too early at 4280(4090)3910 cal BP (Wk 8539) and may be measuring old wood. A similar problem with the dating of old wood was found with determinations from Apalo (see Specht and Gosden 1997:178). The other two determinations are 3140(2840, 2830, 2790)2720 cal BP (ANU 11187) and 3240(2920, 2910, 2880)2750 cal BP (ANU 11186). The determination from the top of unit E is 2300(2000)1880 cal BP (Wk 8540), while that for the layer above with Type X pottery is later at 1560(1290)930 cal BP (ANU 11192).

With these new determinations available, doubt must be thrown on the original date of 2880 ± 70 BP from Adwe squares D/E/F (Beta 55323) mentioned above. The doubts that were earlier raised about this date (Summerhayes 2000a) based on the site's age suggested by the ceramic record are now confirmed.

Anir

Twelve radiocarbon estimates are now available from four sites on Anir and these are reported here for the first time. Four of these are AMS determinations (Wk 7561, Wk 7563, Wk 7564, Wk 7558). Also three sets of paired samples on charcoal and shell were selected from both Kamgot and Melele Cave, and these will be discussed further below. Table 3 lists the determinations.

A word of caution on the limitations of conventional dates is needed. Three of the conventional determinations from the ANU Quaternary Dating Laboratory have standard deviations so great that at two sigma the age ranges have a span of 800 to 1500 years (ANU 11193, ANU 11190, ANU 11191), and this limits the ability to make fine discriminations in the chronology.

The radiocarbon estimates from the Early Lapita site on Kamgot (ERA) include two sets of paired samples. From Kamgot (ERA) Spit 9 the charcoal and shell samples dated to 3380(3330, 3290, 3270)3080 cal BP (Wk 7563) and 3330(3210)3070 cal BP (Wk 7562). From Spit 6 the paired samples are 3360(3320, 3320, 3250, 3220, 3220)3080 cal BP (Wk 7561) and 3210(3080)2950 cal BP (Wk 7560). In both cases the shell calibrations have returned slightly younger ages than the charcoal. One determination on charcoal from Spit 11 Kamgot returned an age of 2960(2850)2760 cal BP (Wk 7564) which is statistically distinguishable from the other four dates. As this date is an outlier to the others it is suspect and contamination is a possibility (Phelan pers. comm.).

One radiocarbon estimate from the Middle Lapita sites of Balbalankin (ERC) is later in age at 2950(2750)2360 cal BP (ANU 11188). A single determination on charcoal (ANU 11191) also comes from the Mission site (ERG) — 3690(3340, 3280, 3270)2850 cal BP. Unfortunately it has a large standard deviation of 800 years, making its use limited. Malekolon (EAQ) has two radiocarbon estimates. The first from just below the main cultural-bearing layer (Spit 11) is next to useless with an age range of nearly 1000 years — 3830(3440, 3430, 3400)2960 cal BP (ANU 11193). The other date was taken from the layer above which is thought to have been redeposited as a direct result of the volcanic eruption on Ambitle at about 2200 years ago (see Licence et al. 1987). This sample has an age of 2750(2110, 2080, 2070)1530 cal BP (ANU 11190) which probably dates the eruption rather than the age of the cultural material.

Of interest are three radiocarbon estimates (two are paired samples) from Melele cave (ERD). The limestone cave is located at the western end of Babase Island and overlooks the southern section of the airstrip. The entrance to the cave is located three-quarters of the way up a 40 m cliff face. Limited excavations to a depth of 1 m (50 cm x 1 m) were undertaken in 1998 by Matthew Leavesley as part of the Anir excavations. A shell sample from 1 m depth gave an age of 3200(3060)2930 cal BP (Wk 7558), while a paired sample on shell (Wk 7556) and charcoal (Wk 7557) from 70 cm depth gave dates 2710(2560, 2550)2350 cal BP and 2740(2360)2210 cal BP respectively. The earliest date is not associated with any artefactual material other than shell midden. The younger date is associated with plain pottery, shell, and bone fragments. It is intended to return to this site and complete excavations in order to ascertain whether pre-Lapita occupation is present.

Discussion

These new radiocarbon estimates from the Arawe Islands and Anir are important for two reasons. First, in refining the chronology of the Lapita ceramic sequence, and secondly in modelling the nature of society that existed on these small off-shore settlements in the Bismarck Archipelago.

Chronology of the Lapita ceramic sequence

After an extensive review of radiocarbon determinations from the Bismarck Archipelago, Specht and Gosden (1997:187) argue that the maximum range of Lapita is 3300–2100 BP. This is slightly later than the 3500 BP argued by Kirch (1997, 2000) based on his Mussau data, and by Spriggs (1997, 1998, 1999). The radiocarbon estimates from Kamgot and the Arawe Islands confirm Specht and Gosden's later age of ca. 3350 BP for the beginning of Lapita at least on the southern New Ireland islands and New Britain.

The radiocarbon determinations also confirm the chronological changes in the Lapita pottery that were predicted on pot form, decoration, motif type, and from Anir also by obsidian. The Kamgot assemblage, from Anir, was argued to be Early Lapita while the Balbalankin assemblage was argued to be Middle Lapita. From the Arawe Islands, the bulk of the assemblage from Adwe squares D/E/F (Units A–D) was argued to be Early Lapita while Adwe square G and Apalo were Middle Lapita and later in age. The radiocarbon dates confirm this, with an Early Lapita ranging from about 3350 BP to 3000/2900 BP, and a later Middle Lapita beginning from 2900 BP. This fits Kirch's chronology for Mussau where he sees a transition between an earlier to later phase to be around 1000 BC or 2950 BP (Kirch et al. 1991:151).

One of the problems with dating the Lapita occupation of the Bismarck Archipelago is the use of conventional dates with wide standard deviations. By themselves they may be limited, yet when plotted in chronological order a pattern emerges. Fig. 4 plots the dates from both Anir and the Arawe islands. A number of dates were not plotted. From Anir these included those dates from Malekolon and the Mission which have too wide a standard deviation to be useful, and the date from Kamgot Spit 11 which was considered to have been contaminated and an outlier. From the Arawe Islands two dates were not included: Beta 27946 from Adwe TP 1 as it is not clear what pottery assemblage it is dating, and Beta 27940 at Paligmete as it was considered to be from a disturbed context. When all the dates are plotted it can be seen that the ages of the Early Lapita assemblages as defined on decoration and form are earlier than Middle Lapita assemblages. The graph also shows a cline between Early and Middle Lapita which would be expected if interaction between the Anir and Arawe communities continued.

It is not possible to date the beginning of Late Lapita nor the end of the Lapita sequence from the Arawe assemblages. From the top of Unit E in Adwe squares D/E/F a date of 2300–1880 cal BP (Wk 8540) provides a terminal date for the partially concreted sand layer. Above this layer and in association with Type X pottery, charcoal provided an estimate of 1560–930 cal BP (ANU 11192). As noted earlier, it

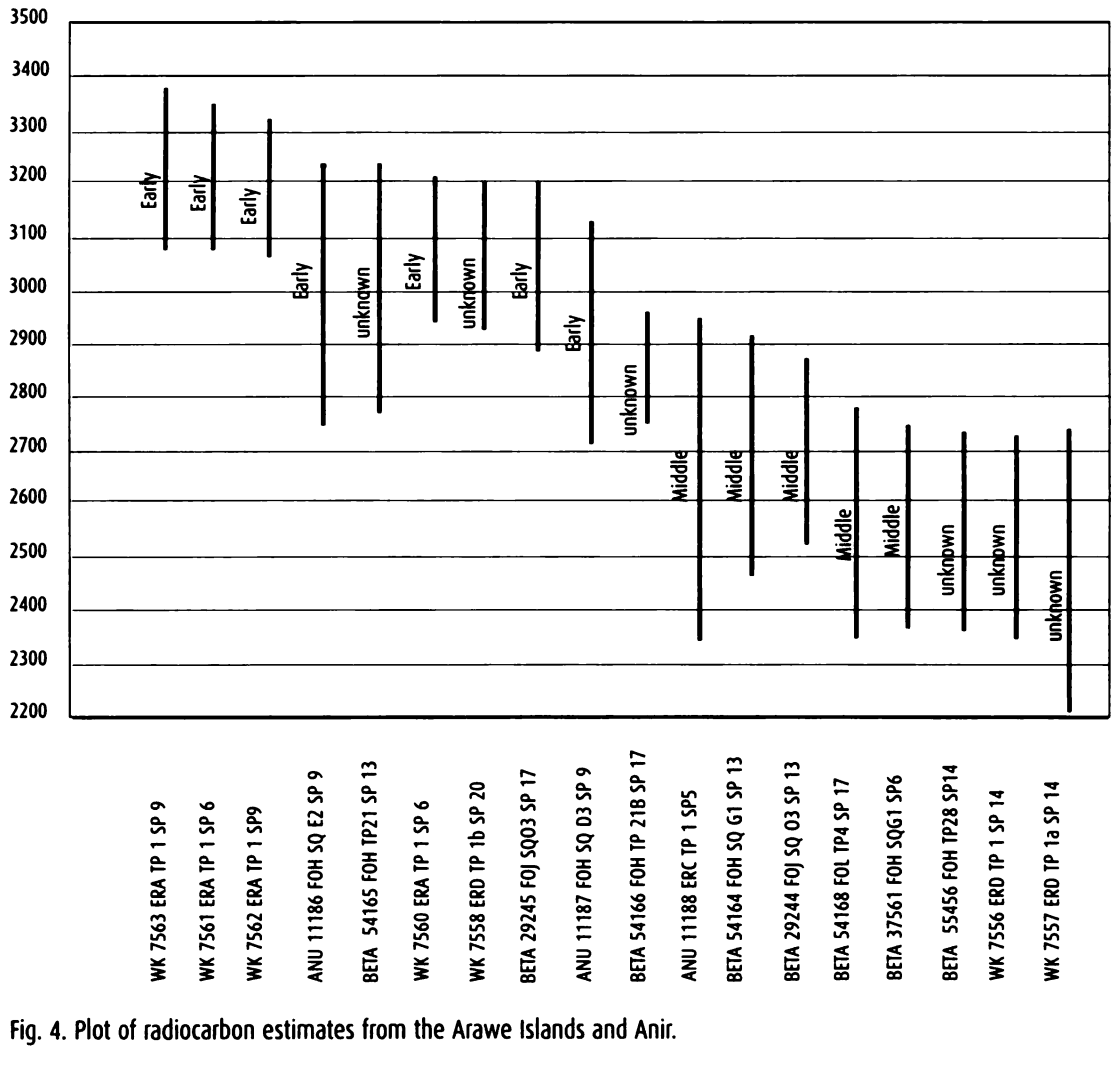

Fig. 4. Plot of radiocarbon estimates from the Arawe Islands and Anir.

has been difficult to date the first occurrence of Type X, and Lilley believes that its production began ca. 1600 BP (Lilley 1988a:96). The Arawe date, although somewhat younger than, but not conflicting with, Lilley's interpretation, provides another insight into dating the production of this unusual ware.

Modelling the nature of society that existed on these small off-shore settlements in the Bismarck Archipelago

It has been argued elsewhere (Summerhayes 2000a) that similar ceramic changes across a number of geographically separated Lapita settlements equate with similar uses of the pottery and are part of a wider social network in which changes in decoration occur at the same pace. This is not what could be expected from a socially passive design that is the result of exchange and the result of contact between socially unrelated groups which produce a similar ceramic. It should be reiterated that many of the motifs that are found in the later Middle Lapita style of the Arawe, Mussau and Anir were not found in the Early Lapita pottery. Their presence is not the result of change in the original corpus of motifs, but represents shared innovations arising from the exchange of information and people. Mussau, the Arawes and other Bismarck Archipelago sites are part of a social network in which change in decoration occurs at the same pace at roughly the same time. Such changes in decoration reflect changes in that network and indicate continuing interaction between these communities.

Conclusion

The addition of new radiocarbon estimates from Lapita assemblages from the Arawe Islands and Anir confirms that the changes that occurred in these sites and Mussau occurred at roughly the same time. These new determinations confirm the chronology for sites in that region that were based on regional comparisons of pottery decoration, form and production.

Acknowledgements

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A Roviana ceramic sequence and the prehistory of Near Oceania: Work in progress

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Introduction

Establishing the distribution of an early-Lapita pottery horizon has been a major goal of Pacific archaeology since the 1950s, when it was first proposed that Lapita pottery marked the initial human colonisation of what was later termed Remote Oceania. The Near Oceanic Solomon Islands (the Solomon Islands including Bougainville and excluding Ontong Java, Te Motu Province and Rennell-Bellona) comprise a major and puzzling gap in the recorded distribution of early-Lapita pottery sites (Green 1978; Kirch and Hunt 1988; Kirch 1997:53; Roe 1992, 1993; Spriggs 1997:128). This paper reports ongoing archaeological investigations at Roviana Lagoon, New Georgia (Fig. 1), undertaken with the aim of understanding the gap in the Lapita record. Ultimately at issue is whether the distribution of early-Lapita pottery was continuous or discontinuous in Near Oceania. This issue has significant implications for our ideas about what Lapita represents. A continuous distribution of early-Lapita pottery across this region would favour the largely indigenous development model of Lapita pottery, or at least raise the probability of the integration of local populations with Island Southeast Asian migrants at an early stage in the development of the Lapita cultural complex. A discontinuous distribution would favour a fast track, avoidance model of Lapita colonisation, where Lapita represents 'foreign' intrusion, by an expansionist society based initially in the Bismarck Archipelago, at the fringes of an already occupied and hostile Solomon Islands. In this model Lapita expansion 'colonies' are confined mostly to offshore islands and are culturally and genetically distinct from the earlier occupants of Near Oceania, and they bypass the Near Oceanic Solomon Islands in favour of a previously unoccupied Remote Oceania.

Opinion amongst archaeologists with an interest in Lapita is divided as to the reasons for the gap in the distribution of early-Lapita sites. Two possible explanations commonly discussed previously are (a) that the gap is purely an artefact of insufficient survey in this region (Green 1978; Spriggs 1997:128) and (b) that the gap directly reflects a discontinuous distribution of Lapita in this region or even complete avoidance of this region by Lapita peoples in the past (Gorecki 1992; Roe 1992, 1993:185; Sheppard et al. 1999b). Some take an equivocal position in relation to these possibilities (e.g. Kirch 1997:53). An additional possibility (c) less often considered is that tectonic instability has reduced coastal site visibility/preservation in the Near Oceanic Solomon Islands (Kirch and Hunt 1988:18). To

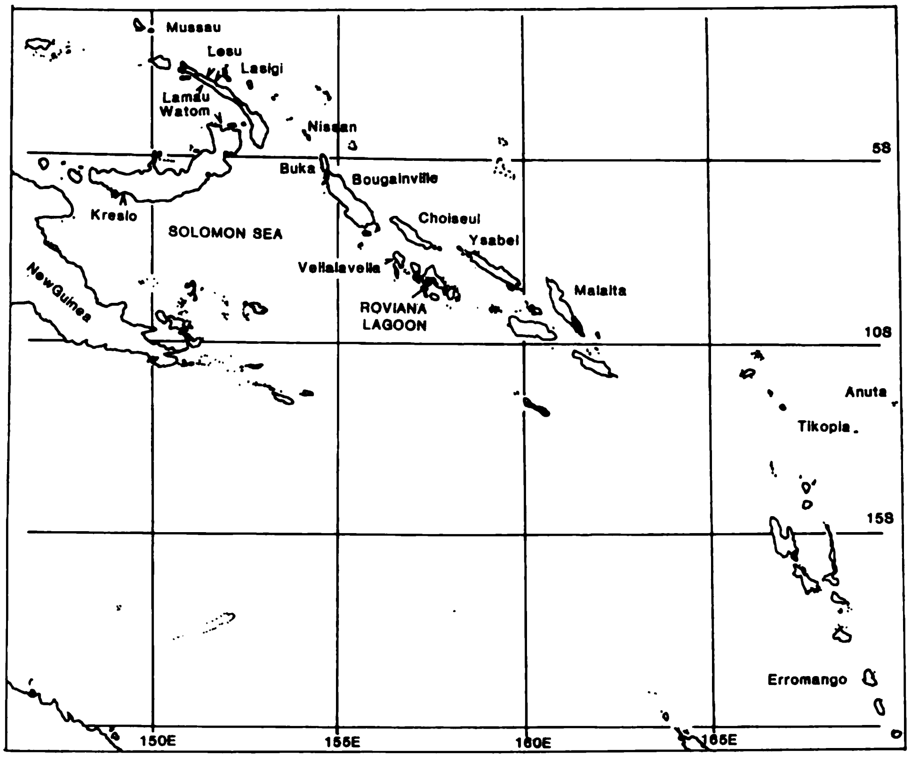

Fig. 1. Location of Roviana Lagoon in relation to places mentioned in the text.

these a fourth possibility is added here (d) that the primarily terrestrial archaeological survey which has occurred in the Solomon Islands has failed to locate Lapita settlements due to their exclusive location in the intertidal zone, comprising stilt houses or small artificial islets. Implicit in this proposition is the hypothesis, related to (c) above, that archaeological deposits resulting from intertidal-zone settlement in tropical waters are easily destroyed or hidden by even slight changes in sea level.

Data pertaining to this fourth possibility will be presented in this paper, some of which is taken to indicate that intertidal ceramic scatters from such occupation can be regarded as a fragile site type which can be expected to be either obscured by coral growth, or largely obliterated through wave action, by relatively small rises *or* falls in sea level. This last is an important point, as ordinarily one might expect a fall in relative sea level to tend to preserve a coastal terrestrial settlement. In the case of an intertidal pottery deposit resulting from, for example, a stilt village, a slight fall in sea level will potentially move the deposit through a higher-energy environment in the upper-intertidal zone; one less favourable for site preservation for various reasons discussed below.

Previous surveys (Miller and Roe 1982; Reeve 1989) suggested there were numerous intertidal surface ceramic/lithic scatters like the site reported in detail by Reeve (Paniavile) throughout Roviana Lagoon and elsewhere in the Western Province of the Solomon Islands. At the last Lapita conference in Port Vila, some initial findings from the first two seasons of the New Georgia Archaeological Survey were reported (Sheppard et al. 1999b). It was tentatively concluded that:

1. Roviana intertidal sites might have been formed by the erosion of beachfront villages rather than as a result of intertidal occupation in the past;
2. The lack of Lapita pottery in the Roviana data strengthened the hypothesis (Roe 1993:185) of no early-Lapita occupation in the central Solomon Islands, through the inference that there was no Lapita occupation in the Western Province.

Additional sites, identified as late-Lapita occupation, have since been discovered during the 1997–1998 field seasons. Further consideration of the evidence relating to Roviana intertidal site formation processes, combined with this new ceramic data, leads me to reassess both of the previous conclusions.

It is proposed that all of the ceramic surface concentrations recorded in the intertidal zone during the course of the New Georgia Archaeological Survey are likely to represent intertidal occupation, forming an intertidal occupation sequence which probably included rare, as yet undiscovered, early-Lapita sites. Such a pattern of intertidal occupation can reasonably be expected to have been a feature of at least the New Georgia area through this period, and conceivably extended over the wider region comprising the Near Oceanic Solomon Islands Lapita gap. A sampling argument with supporting data will be presented suggesting why such undiscovered intertidal early-Lapita sites are likely to exist and how these might remain undiscovered despite a considerable accumulation of archaeological survey records for the Near Oceanic Solomon Islands region. A number of methodological issues are implicit in this argument, ranging from archaeological survey methods through to analytical methods/techniques by which archaeologists might infer the past location, scale and intensity/duration of occupation for such intertidal sites, and also post-depositional alterations to them. Some discussion of these issues is included in this paper, but treatment of these will be limited due to considerations of space and also because much of the methodological development is still in progress in my PhD dissertation.

The archaeological value of intertidal-zone sites in Near Oceania

Despite a program of considerable terrestrial site survey and test excavation, it has yet to be demonstrated that the ceramics found in the water from Roviana Lagoon have a contemporaneous ceramic component preserved on land. Instead, the Roviana results suggest intertidal sites might be the *only* ceramic sites of the Lapita ceramic series for some parts of Near Oceania.

Research within Near Oceania which has located ceramic sites with similar observed or inferred intertidal reef-flat locations include Tarmon on Nissan (Spriggs 1991; Wickler 1995), Talepakemalai in Mussau (Kirch 1987, 1988, 1997; Kirch et al. 1991), Wickler's survey of intertidal reef flats on Buka (two reef sites on Sohano island associated with eroding beach sites and the DJQ reef site near Kessa plantation) (Wickler 1995), and the Kreslo site on the south coast of New Britain (Specht 1991).

The Roviana intertidal sites are similar enough to the Buka/Nissan reef sites and Kreslo in ceramic style, location and morphology to infer that such sites are common in the Near Oceanic region. Talepakemalai Area B, with early-Lapita ceramics, shows the antiquity of stilt occupation over water in the region (Kirch et al. 1991), while Area C ceramics (Kirch et al. 1991) may indicate that this pattern of stilt occupation persisted at Talepakemalai into the period of the Buka reef sites, Kreslo, and the early part of the Roviana sequence.

The ubiquity of such sites in the intertidal zone is therefore becoming apparent for some parts of Near Oceania. If archaeologists do not pay attention to such sites they are potentially overlooking significant sections of the archaeological sequences of this region. Early-Lapita ceramics (Green 1978, 1979, 1990; Summerhayes 2000:231–232) have not yet been found in Near Oceania anywhere south of the Bismarck Archipelago, their next appearance being in Remote Oceania (the Reef/Santa Cruz islands, Vanuatu and New Caledonia). This may in part be due to the lack of intensive regional surveys, but is also potentially due to an intertidal settlement pattern in the past in Near Oceania. While formal intertidal survey has been reported in some studies (e.g. Wickler 1995:63), it is an aspect of coastal survey that is probably neglected except where there are materials eroding from adjacent wave-cut beach sections. The apparent early-Lapita gap in the Near Oceanic Solomon Islands thus requires attention to the archaeology of the intertidal zone in this region.

While the view is still sometimes expressed in archaeology today that surface distributions of artefacts are best either disregarded or used merely to flag potential subsurface remains, others have the conviction that surface archaeological phenomena have intrinsic archaeological potential (Ebert 1992; Sheppard and Green 1991; Sullivan 1998). There are some archaeological information advantages when studying intertidal surface ceramic scatters. It is possible to investigate a large sample of these sites with relatively small effort, making stylistic seriation studies feasible. In contrast to many terrestrial sites in Near Oceania, where gardening has frequently degraded the information-content of ceramic assemblages, sherds collected from the deeper margins of intertidal sites are typically quite large and have well-preserved surfaces. Spatially broad samples of these large sherds and of lithic artefacts can be relatively easily recovered, in comparison with test excavations of small areas of terrestrial sites. Against these advantages, assemblage attrition would seem to have been severe in most cases, as discussed below, and has limited the sample of decorated sherds to an unfortunate degree. While a reasonably large sample of sherds can be recovered, compared to test pits in low-density subsurface ceramic deposits, for some purposes the sample size from the Roviana surface sites is marginal or insufficient.

Ceramic fabric analysis can proceed as for a terrestrial subsurface site, to identify patterns of prehistoric transfers of pottery. Direct dating of organic or mineral inclusions of the pottery is possible. AMS radiocarbon dates were obtained for two sherds from the Roviana intertidal assemblages. Distributional studies can be entertained for intertidal surface scatters, as for terrestrial counterparts.

While it might be argued that surface sites potentially present a confusing palimpsest of remains from differing time periods, the same can be true of buried sites (Dunnell and Dancey 1983). The duration of deposition of the chrono-stratigraphic unit is not necessarily longer than that of a subsurface deposit, particularly in an area like Roviana Lagoon where Holocene rhyolitic volcanism and associated tephras are absent, and tsunami wave exposure is negligible, and deposition events likely to provide sterile stratigraphic layers do not appear to have been common or widespread, in contrast to much of the Bismarck Archipelago and Vanuatu. Well-preserved buried sites, with the range of archaeological materials present in the Mussau 'intertidal' sites (Kirch 1987, 1988; Kirch et al. 1991), were not found during the Roviana survey. Within the Lagoon, alluvial deposition along the mainland river flats is probably the geomorphological process most likely to create stratified sediments of this type, preserving a wider range of archaeological materials. While finds were recorded from this geomorphological setting, to date test excavation has produced only minor archaeological deposits. As for the Buka and Kreslo intertidal sites, the Roviana sites comprised exposed ceramic and lithic surface scatters including in some localities sherds within sediments. The geomorphological processes which supplied an overburden of protective sediment to the Mussau sites do not seem to have occurred along the shores of the Roviana Pleistocene/Quaternary raised-reef barrier islands, where most recorded sites were found.

A disadvantage of working primarily with surface intertidal sites is that organic evidence for prehistoric economy and subsistence is lacking or difficult to associate with the pottery. Shell artefacts are unlikely to be preserved in such surface sites. No structural remains were recorded in any of the Roviana surface intertidal sites, although bases of posts may be preserved in some unexcavated soft-sediments. Ultimately, stratified deposits which contain a record of changing pottery styles have a valuable role for testing any seriation developed from surface sites.

Intertidal-zone sites in Near Oceania

The following is a brief inventory of the evidence for intertidal occupation from the Near Oceanic archaeological record excluding the Paniavile site in Roviana Lagoon reported by Reeve (1989).

The Tarmon site on Nissan has been interpreted as "probably representing settlement on a former sand spit" (Spriggs 1991) although the possibility of stilt villages has also been entertained (Spriggs 1997:126). Lapita, Yomining and a few Sohano-phase sherds were present. Stone adzes, obsidian and many kilograms of oven stones were also recorded (Spriggs 1991; Wickler 1995:194–196).

Wickler interpreted Sohano site DAF outer reef portion as suggestive of stilt-house settlement extending to the edge of the drop-off to the reef passage. He considered it unlikely to be part of an eroded former beach deposit. Late-Lapita ceramics were present on the outer reef and Lapita/Sohano-phase ceramics were present on the inner reef and adjacent land. Spatially discrete concentrations of sherds interpreted as disposal patterns from individual stilt dwellings formed the basis of at least three collection units. These outer-reef concentrations of sherds were noted as comprising the larger and less damaged sherds (Wickler 1995:185–191).

Sohano site DJQ had Lapita ceramics on the reef extending to the edge of deeper water, but these were not found in adjacent test pits on land, other than as occasional worn sherds most likely displaced from the reef deposit. Lapita sherds were found cemented into the reef limestone in the seaward portion of the site. Volcanic 'cooking stones' were also present. As for DAF, dense clusters of ceramics were interpreted as suggestive of stilt houses (Wickler 1995:191–194).

The Talepakemalai site on Eloaua Island has been interpreted as including stilt settlement in a shallow lagoon before 2200 BP, with Area B yielding a large sherd assemblage of early-Lapita ceramics in addition to abundant palaeobotanical and faunal evidence (Kirch 1987, 1988). Area C comprised a later Lapita style of ceramics, also inferred to represent stilt occupation.

Kreslo (FNT) on the south coast of New Britain comprised a similar scatter of ceramics and lithics at a reef-passage location, at a depth underwater that would only be exposed at the lowest tides of the year. It is similar to the Roviana pattern in that no ceramics were found on land or in the adjacent rock shelter deposit (Specht 1991). Specht considered pile settlement the most likely explanation for the Kreslo pattern, and noted the Watom-like character of many of the decorated sherds. Specht considered the possibility that such pile settlements over water might represent one aspect of Lapita cultural diversity, and noted the consequences for archaeological survey methods in the region.

Some Arawe sites were located within beach deposits (Gosden 1989) and might also be interpreted as stilt dwellings over water.

Understanding intertidal-zone surface distributions

One research focus has been to further develop archaeological methods for investigating intertidal reef sites. In contrast to subsurface sites formerly located in the intertidal zone, like Talepakemalai, for sites comprising mainly surface scatters of artefacts in the intertidal zone, the archaeologist is very obviously dealing with a different sequence of formation processes, and a different set of archaeological values and techniques apply as a result. Aspects of the research methodology which diverge from those normally applied to surface sites on land are briefly outlined below.

Survey

Formal intertidal survey during seasons of low tides was conducted in addition to the usual coastal and inland transects and rock shelter tests. During the early stages of the New Georgia archaeological survey in 1996 field work focused on the recording and investigation of previously reported sites. In addition to visiting reported intertidal ceramic sites, substantial areas of coastal land and some inland areas were surveyed in the course of recording the extensive archaeological evidence pertaining to the late-prehistoric and ethno-historic periods (Sheppard 1996; Sheppard and Walter 1998; Sheppard et al. 1998; Sheppard et al. 1999a; Sheppard et al. 1999b; Sheppard et al. 2000). For the 1997–1998 field seasons, ceramic site survey was concentrated in the Kaliquongu area of Roviana Lagoon (Fig. 2) where only the Gharanga Stream intertidal ceramic site had been recorded previously. Field work in 1997 and 1998 was planned around systematic intertidal survey during months of low tides (June–August), and yielded a denser distribution of ceramic sites than had previously been reported anywhere in the Lagoon, with a greater range of stylistic variation thought to represent a longer sequence, including a late-Lapita site. Survey coverage of the intertidal zone within this smaller area of Roviana Lagoon was not completed. Access to many areas was difficult due to dense mangrove cover and those areas with soft sediments were impassable; in addition, archaeological visibility was probably low in such areas for intertidal

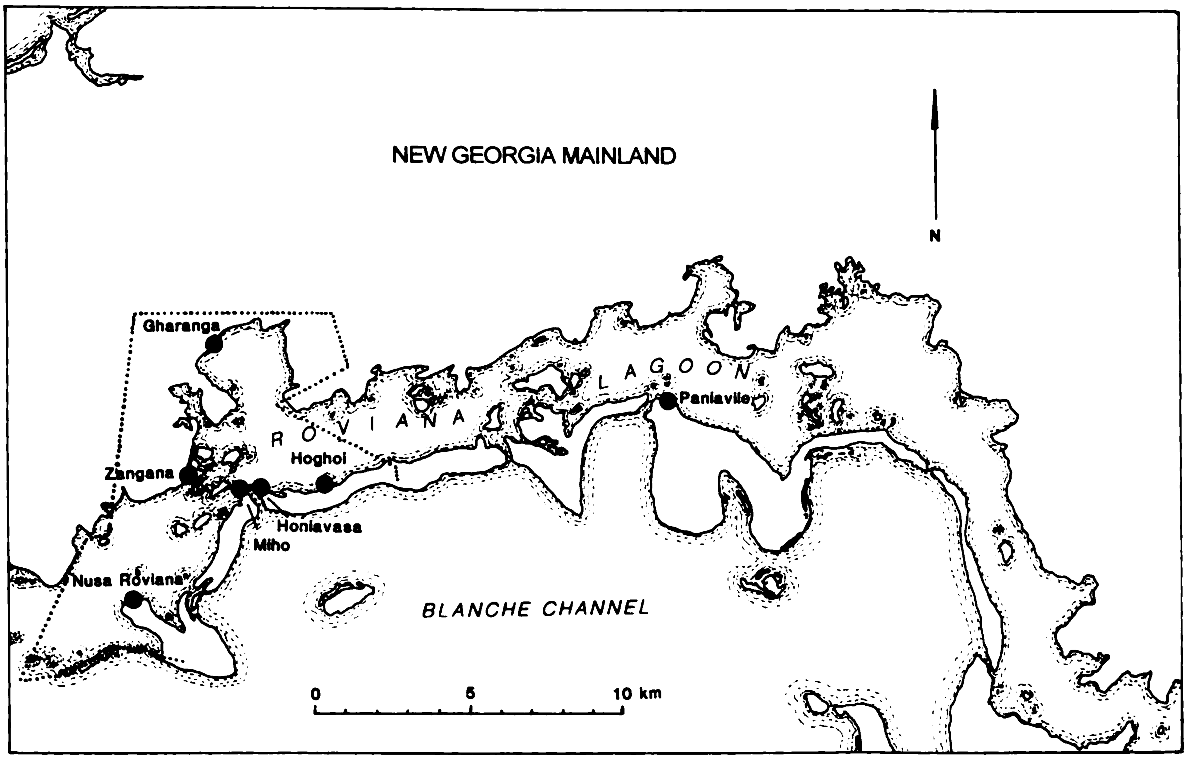

Fig. 2. Location of analysed site assemblages. Limits of 1997 intensive intertidal survey are shown as a dotted line.

ceramic scatters. It is worth noting in this regard that the Talepakemalai site, located beneath fine sediments below the watertable, was discovered indirectly as a result of airport construction revealing adjacent terrestrial sites. Similar sites may well exist under terrestrial sediments at Roviana Lagoon within the survey area. A number of find spots comprising single sherds or low numbers of sherds were recorded on soft sediments during the Kaliquongu intertidal survey. Some aceramic scatters of oven-stones and hammer stones were also noted.

On Honiavasa a late-Lapita site was located on the reef flat adjacent to the channel at the inner end of a major deep-water navigable passage into the lagoon through uplifted coral barrier islands (Fig. 2). Locations of other major (post-Lapita) ceramic sites included reef-passage site locations and other mainland and barrier-island locations (Fig. 2). Only larger sites from which several hundred sherds were collected and analysed are shown in Fig. 2.

Collection, field conservation and subsurface testing

Sites were surface collected either using *point provenancing* for individual sherds (initial collection on the Zangana site) or in a *grid of multiple transects* (second collection at Gharanga, second collection at Zangana, second collection at Hoghoi, sole collection at Honiavasa), or as a *single collection unit* (three collections at Paniavile excluding initial collection by Reeves/Spriggs, initial collection at Gharanga, sole collection at Miho, initial collection at Hoghoi, sole collections at Nusa Roviana and Kopo). Sherds in good condition, when allowed to dry, commonly displayed surface exfoliation, and occasionally disintegrated entirely, as reported by others for similar salty sites (Coote and Sand 1996; Specht 1991). Plastic bags tended to puncture, and only prevented sherds from drying for a limited period and sherds suffered a significant amount of mechanical damage when bagged together. A supply of rigid waterproof containers was found preferable to plastic zip-lock bags for field collection. Initial desalination was done at the field base using several changes of rainwater in plastic basins. In the absence of an available and effective conservation treatment non-destructive *in situ* documentation might be a viable alternative, including recording of: individual sherd locations; site micro-topography; and style, form and fabric categories, with limited samples retained only as necessary. One conclusion arising from ongoing spatial analysis of these sites is that stylistic distributional information is significantly degraded if during initial collection sites are treated as single spatial units. It is suggested that a cautious approach would be to remove as little material as possible unless detailed spatial records can be made in relation to a durable datum.

Site area

Site areas were difficult to determine beyond a rough estimate during reconnaissance survey, due to the diffuse nature of the surface scatters, and are given here as a general guide only. Honiavasa 1800 m^2, Miho 1200 m^2, Hoghoi 1300 m^2, Zangana 3000 m^2, Gharanga 1000 m^2, Paniavile (after Reeve 1989) 500 m^2 (Paniavile had undergone major modification prior to the present study).

The relationship between these areas and the extent of past occupation is being investigated through distributional analysis of sherd size, stylistic variation and fabric variation. Rare sherd conjoins will also be examined in this regard. Sites are turning out to be quite varied in this respect, with only sub-areas of some sites thought at present to reflect primary deposition.

Sample sizes

Sample size is an important consideration when interpreting similarities between archaeological assemblages (Kintigh 1984; Kirch et al. 1987). Ceramic sample sizes by site are given in Table 1. 'Sherd total' denotes the total number of sherds entered into the database. The number of sherds retaining a vessel exterior surface area greater than 15 cm^2 are given as a rough guide for comparing site assemblages excluding very small sherds of limited archaeological value. The number of lip and neck sherds by site for all sherd sizes is shown, although it should be noted that sherds which included both lip and neck portions of the vessel will have contributed to both the lip and neck counts. Rim numbers are not shown because rims were defined as the portion of the vessel between the lip and the neck inflection in this study, rather than a more inclusive definition encompassing several vessel parts used by some researchers.

As discussed below, analysis of vessel completeness using lip sherds suggested that sherds in the samples were from separate vessels in most cases. This probably holds true for neck sherds also, and most separate lip and neck sherds are probably from separate vessels also, by the same line of inference. The sherd samples therefore represent a larger number of vessels than total sherd quantities would suggest were vessel completeness higher for these assemblages. Nevertheless, samples are on the small side for most purposes and this highlights the need for attention to those traits that are common occurrences. In making external comparisons, traits that are common in site assemblages elsewhere but absent in the Roviana site samples can also be usefully considered. Ceramic traits that were rare occurrences at best in site assemblages were not regarded as particularly significant, as presence or absence could easily be a result of the small sample size. The rare dentate-stamped sherds found in two sites are therefore not used as the primary evidence for identifying a late-Lapita site and distinguishing them from post-Lapita sites, but instead are lumped with other stamped sherds as a more numerous category.

It would have been possible to obtain larger samples from some sites, particularly Zangana, where the main collection comprised a one-fifth transect sample. As an aside, it is possibly fortunate

Table 1. Characteristics of ceramics collected from Roviana Lagoon.

SITE	SHERD TOTAL	NO. OF SHERDS >15 CM^2	LIPS	NECKS
Honiavasa	445	320	77	173
Gharanga	278	135	34	74
Hoghoi	861	155	87	153
Miho	382	205	65	104
Zangana	861	223	80	170
Nusa Roviana	116	41	9	26
Paniavile	654	193	66	129

that full collection did not occur as long delays in obtaining an export permit for Zangana sherds led to significant salt-crystallisation exfoliation damage in transit. The same would appear to be true for some of the Paniavile sample, which had been previously collected by villagers following a visit by Reeve and Spriggs (Reeve 1989), and stored in sacks in an adjacent rock shelter for some years. Observation of the significant effects of salt damage in these two instances led to the routine implementation of field desalination practices during subsequent field work.

Lithic analysis

Whole and fragmented water-rounded stones of volcanic origin were scattered with ceramics. Samples were retained, and for the Hoghoi site stones were transect collected and described according to a retained type series, weighed and characterised as either fragmented or whole before being cached at our home base. The retained samples have not yet been examined petrographically. Many smaller unfractured pebbles were present, around 5 cm maximum diameter, and analysis will address the possibility that many of these smaller unfractured stones had non-cooking functions such as net weights or nut-cracking stones. Many of them seem too small to function efficiently as cooking stones.

Five flaked and ground stone adzes were recovered, including at least one plano-convex sectioned example. Other adzes (one an unground preform) and ground axes, reported to have been collected from ceramic site locations and from gardens, were examined and photographed. Petrographic examination of lithic artefacts is in progress.

Site-formation processes

The four principal lines of inference for formation processes of the Roviana reef sites are discussed below.

Geomorphology: Professor John Dodson of the University of Western Australia and a student, Sarah Grimes, are studying the age of the present mangrove system with the aim of establishing the antiquity of present sea levels. Results are not yet available.

Site location: Like the Buka reef sites, ceramic scatters were located close to the edge of the reef flat in most cases, adjacent to deeper water, and did not extend above the high-water mark, except as occasional weathered sherds most probably displaced from the reef onto land by people or wave action. Since we know that similar sherds often survive on land in Lapita sites, the absence of sherds on land is unlikely to be an artefact of differential preservation of terrestrial versus marine areas of sites, and therefore it seems, as Rowland Reeve noted in 1989, that the high-tide mark is the limit of deposition in the past. It seems unlikely that all occupation was formerly on land and was all equally inundated by the sea. This leaves two possibilities. One is that sherdage was deposited as refuse in the sea from terrestrial settlements, of which we have no trace. Given the extent of project survey and test excavation, this seems unlikely. The other is that the ceramics originated as primary refuse from stilt or artificial islet villages (the latter now defluved by the sea into a scatter of coral rubble). This is the interpretation currently favoured.

The degree of damage on sherds: It was found that many sherds would suffer surface exfoliation due to salt-crystallisation if allowed to dry after collection, and the pristine surface condition of sherds from the deeper portions of sites suggests they have not undergone such damage in the past. The argument is put forward that, were sites formerly located on land, they must have been inundated in a single event to have avoided salt crystallisation damage through cyclic drying, so evident on the high-water landward fringe of sites and also on those site assemblages which were incorrectly handled following retrieval. Stephen Wickler makes a similar point in relation to intertidal sherds at Buka (Wickler 1995:187, 192–193). The small size and poor condition of those Roviana sherds that were found along high-water strandlines of sites also suggest that intertidal sites may be effectively destroyed by falling relative sea levels. This observation is significant for an argument made in this paper that intertidal settlements may have been the dominant coastal settlement type in the Near Oceanic Solomon Islands during the early-Lapita period.

Ceramic quantities: Quantities provide an indicator of the intensity / duration of occupation, and vessel completeness as an indicator of post-depositional sherd attrition. This is discussed in more detail below.

Ceramic quantification and intensity and duration of occupation

Ceramic quantity has been widely used in archaeology as a guide to the intensity and duration of occupation in the past (Varien and Mills 1997; Varien and Potter 1997). As an example of the application to reef sites in Near Oceania, Stephen Wickler noted for site DJQ, the reef site near Kessa Plantation, that sherds were: "Thinly scattered over the reef, suggesting limited utilisation of these areas prehistorically" (Wickler 1995:192–193).

Similarly scant distributions were observed for all Roviana reef sites; the interpretation of these differs, however, following further development of the 'sherds as vessels' approach to archaeological ceramics and formation processes (Fontana 1998; Orton 1993; Schiffer 1995).

The observation that only one rim-lip sherd per vessel could be identified for highly decorated sherds led to a study of the degree of vessel completeness of assemblages. Intuitively, for sites thought to be accessible across their entire horizontal extent as surface exposures, most pieces of any vessel rim-lip ought to have been represented in the deposit initially. Over time, an assemblage can be expected to become more and more broken, until many pieces are so small as to be no longer recoverable by an archaeologist. Eventually, after a substantial proportion of the sherds are thus removed by post-depositional processes, the assemblage should present a variety of degrees of vessel completeness, where some vessels are represented by several rim-lip sherds, others by only one, and some by none. Beyond this state a substantial further attrition of sherds must occur to render an assemblage of predominantly rim-lip sherds. Logically, the majority of vessels will no longer be represented in such an assemblage.

Modelling approaches to quantify this process have been undertaken with limited success in the past, due to the difficulties inherent in modelling the breakage process (Orton 1982, 1993:178). The approach taken to the Roviana ceramics was to treat the assemblages as though they had remained in a constant state of fragmentation since deposition — the state of fragmentation of the recovered sample. This circumvents the complexities of modelling breakage, and reduces the matter to a sampling problem: What hypothetical population of vessels broken in this manner does this sample represent, given the degree of completeness of vessels in the sample? By circumventing the problem of variation in assemblage fragmentation over time, estimation of a parent deposited vessel population is possible. While further development of this approach is currently in progress, it is almost certain that the number of vessels deposited in the past was much greater for the Roviana sites than direct interpretation of quantities of sherds would suggest. It is suggested that the raw quantity of sherdage observed by the archaeologist may bear little relationship to the intensity or duration of site use. This means that Wickler's inferences about the low intensity or short duration of occupation of the Buka intertidal sites should be treated with caution in the absence of information on vessel completeness. The Buka intertidal sites may have been a more significant component of the Lapita occupation of that region than raw quantities of sherds would suggest. This is clearly the case for the Roviana intertidal sites.

Ceramic quantification

A detailed treatment of this general method of estimating parent assemblages is not given in this paper. This information on work in progress is presented principally as a justification for the arguments made in this paper that intertidal surface sites may represent more significant occupations than raw sherd quantities would suggest, and can be shown to be fragile in that they display extreme levels of sherd attrition even in a favourable location such as the sheltered waters of the Roviana Lagoon, where extensive slightly raised Pleistocene-age barrier reefs protect lagoon shore lines from *tsunami* and tropical-cyclone storm waves.

The more decorated of the Roviana rim-lip sherds were sorted into vessel groups, using decoration, form and fabric to identify vessel groups in a probabilistic manner. Two measures of mean assemblage vessel completeness were calculated from these groups. Firstly, the mean percentage of lip circumference represented in the sample was calculated, using a rim percentage chart to take the raw measurements (Egloff 1971). Secondly, the mean number of lip sherds per vessel was calculated. This second figure was used in conjunction with data on sample assemblage fragmentation (which yielded an expected number of lip sherds for hypothetical complete vessels in the same state of brokenness).

These two types of data on vessel completeness were used in simple simulation experiments to estimate the percentage of sherds that must be removed to create an assemblage with the degree of completeness observed at Roviana. The second measure of brokenness/completeness (mean number of sherds per lip) was used in conjunction with non-parametric statistical techniques (Chao 1984), adapted by Dr Robert Gentleman and Dr Alan Lee of the Statistics Department, University of Auckland, to get very broad estimates of the parent population size from which the site samples were drawn.

Although this work is still in progress, this treatment of the material is relevant to Wickler's interpretation of the Kessa reef sites as indicating limited utilisation of these areas prehistorically. The findings so far indicate that on average only one per cent or less of the deposited sherds in the Roviana sites are making it into the archaeologist's assemblage. One preliminary finding is that less than one in eight deposited vessels are expected to be represented in the recovered sample of rim-lip sherds for Roviana assemblages as a whole, despite the extensive surface exposures of sherds.

Not only is the potential for stylistic bias in these remnant assemblages high, but interpretation of the intensity and duration of occupation based directly on the quantity of sherdage observed would be seriously in error. Roviana sherd density would have been much higher, approximately 100 times greater, in the past, and the estimated minimum number of vessels represented would have been at least eight times the minimum number of vessels represented in the assemblage as calculated by more conventional methods.

These preliminary results for the highly decorated rim-lip sherds suggest that the total sample including plain rim-lip sherds of 447 rim-lip sherds in the Roviana intertidal assemblage can in this way be thought to represent a minimum of approximately 3576 vessels deposited in the sites that were surface collected in the present study. The maximum number is potentially far higher and is unlikely to be established except within limits so broad as to be meaningless. This is in stark contrast to sites with high vessel completeness, where many recovered lip sherds will be from a single vessel, and almost all deposited vessels can be expected to be represented by at least one identifiable rim-lip sherd, given a medium state of assemblage brokenness.

This finding strongly indicates severe post-depositional weathering attrition of the deposited Roviana sherd population, as subsurface test excavations indicate densities of buried sherds sufficient to account for only a small fraction of the missing pottery.

Radiocarbon dates

All organic materials seen within sherds or on the surface of sherds which might conceivably be dated were submitted for evaluation by AMS specialists. A charcoal inclusion within a body sherd from the Paniavile site was dated by the Arizona AMS Laboratory to 2130 ± 90 BP (AA33504). This calibrates to between 390 BC and 30 AD at 95.4% confidence limits. Some smoke-derived carbon on the exterior of a plain pot from the Hoghoi site was dated by the Rafter Radiocarbon Laboratory of New Zealand to 2619 ± 45 BP, calibrating to multiple points between 910 BC and 600 BC at 95.4% confidence limits. Unless there is an old firewood effect built into the smoke-derived carbon sample, these dates combine to yield a minimum span of 210 years for the Roviana intertidal sequence.

Quartzo-feldspathic/calcite temper sands found in some Roviana pottery are potentially suitable for thermoluminescence dating. James Feathers at the University of Washington in Seattle is currently experimenting with nine of these.

Ceramic style

Roviana ceramic style, particularly for the Paniavile site, has already been discussed by Reeve (1989; see also Kirch 1997:283) and has been described as a late variant of Lapita or derived from the Lapita tradition. Principal characteristics of a tentative Roviana stylistic series are outlined below.

The sherds from all sites show abundant evidence of paddle and anvil construction of the rounded body/base of the vessels. Globular vessels appear to have been formed from a single lump of clay, while carinated vessel forms appear to have been achieved though attachment of separate conical upper-body slab and possibly a further separate conical rim slab. Flange rims (Poulsen 1987) more obviously entailed attachment of separate upper rim slabs. No paddle-impressed exteriors were seen. Typically, vessel interiors exhibit small anvil marks arranged in multiple latitudinal circles between the base and the neck. Many vessels appear to have undergone a secondary interior smoothing using a larger anvil, resulting in a more even interior with a distinct edge encircling the vessel orifice. Many vessels with excurvate rims exhibit multiple latitudinal spatulate tool impressions around the neck and rim, interpreted as evidence of forming the excurvate rim against a flexible spatula used externally. These marks are superficially similar to brush marks, but have a different cross-section to bristle striations, and multiple marks do not share common start and end points, in contrast to the pattern that would be expected from brush marks. Decorative techniques include predominantly linear incision, opposed pinch fingernail impression, punctation, usually as a single band, and linear stamping, the latter including varied coarse dentate and wavy occurrences. Applied decoration is present in great variety, on a minority of sherds in all sites. Sherds typically have a high percentage of moderately sorted to well-sorted sand temper, discussed in more detail below in relation to evidence for ceramic transfers.

The Honiavasa ceramic assemblage falls more clearly within the late end of the Lapita ceramic series as defined by Golson and Green (Golson 1971; Green 1979) than do other Roviana intertidal sites, hence use of the terms 'early Lapita', 'late Lapita' and 'post-Lapita' in the context of this paper. No general applicability to the broader region is implied. The Honiavasa ceramic assemblage is distinguished from other Roviana assemblages as probably the earliest in the local series by the following characteristics (see Figs: 3–5):

1. Rare examples of linear dentate and other linear stamping (taken together, examples of various kinds of stamping are quite common in this assemblage).
2. High frequency of carinated sherds, and of neck sherds with dimensions indicative of carinated vessel forms. These tend to have bounded incised motifs, and are tempered exclusively with placered volcanic sands.
3. Presence of several compound (constructed by adding/joining a slab to the top of an everted rim) flange rims (after Poulsen 1987:57), of which all but one were of exotic quartz-calcite temper.
4. Low frequency Lasigi "class 2 modification" (Golson 1992) or "scalloped method (a) rims" (White and Downie 1980:Fig. 8i–k), being horizontal deformation of the lip into a wave form.
5. Absence of 'Gharanga' type vessels (discussed below).

Carinated sherds are similar to those illustrated by Kirch and Rosendahl for Anuta, Layers II and III of AN6 (Kirch and Rosendahl 1973:Fig. 12a,c), with the upper body above the carination tending to be conical or slightly concave in general rather than convex, though not exclusively so. There are decorative similarities to sherds from Lasigi on New Ireland, which probably indicates a similar age. A number of everted rims from the Honiavasa site have a band of opposed pinching around the outer lip, a motif which also occurs in low frequency in the Paniavile site. A small intertidal surface collection from Nusa Roviana Island also included a vessel marked with a coarse-linear-dentate stamp (see Fig. 3:NR.34) similar in form and general appearance to those from the Mussau EKQ rock shelter site (Kirch et al. 1991:Fig. 4h–i), but the assemblage from the Nusa Roviana site was quite different in many ways from Honiavasa, and the dentate-stamped occurrence may be an heirloom effect, or materials from two or more periods may be represented. At this site is a vessel sherd notable for the presence of dentate stamping, opposed pinch fingernail impression, deep incision and vertical perforation of the lip.

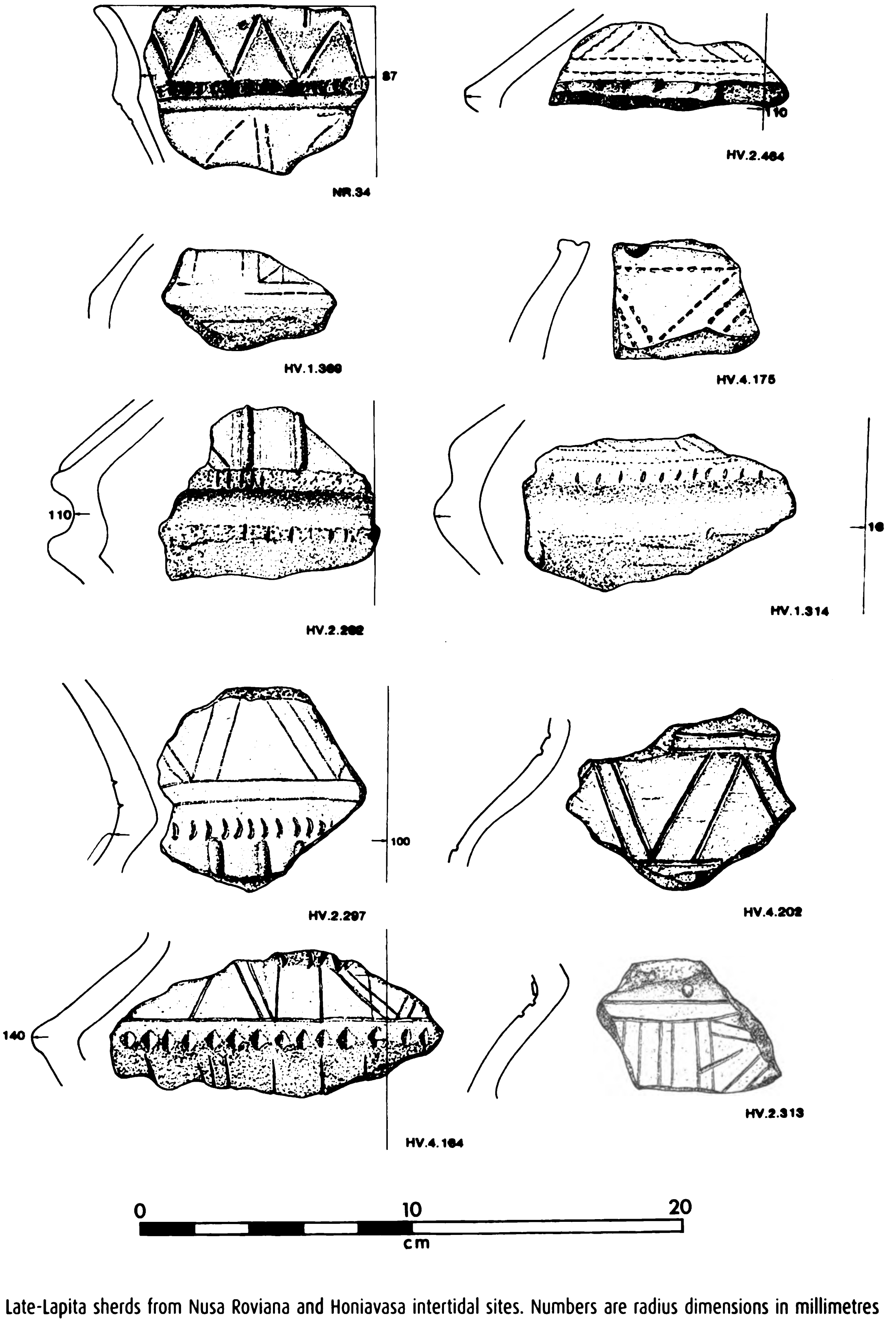

Fig. 3. Late-Lapita sherds from Nusa Roviana and Honiavasa intertidal sites. Numbers are radius dimensions in millimetres taken with curvature gauges at the points shown by arrows pointing to the left margin. Horizontal lines represent measured radii. Vertical lines represent estimates of location of the central vertical axis of vessels.

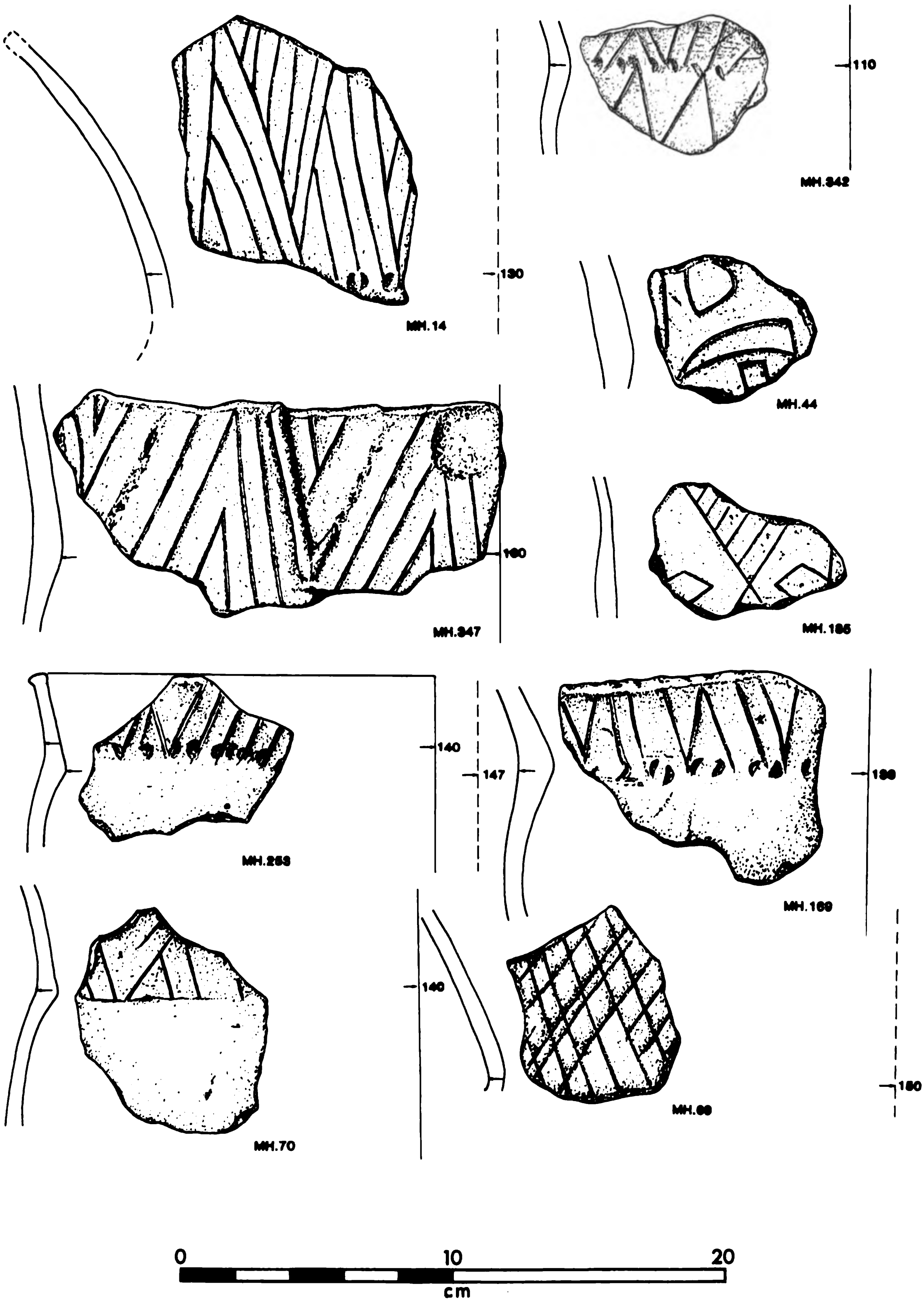

Fig. 4. Post-Lapita sherds from Miho site. MH.44 and MH.185 have quartz-calcite hybrid temper; all other sherds shown have placered volcanic tempers. Dashed vertical lines represent poor estimates of ventral vertical axis based on uneven (non-circular) measurement horizons.

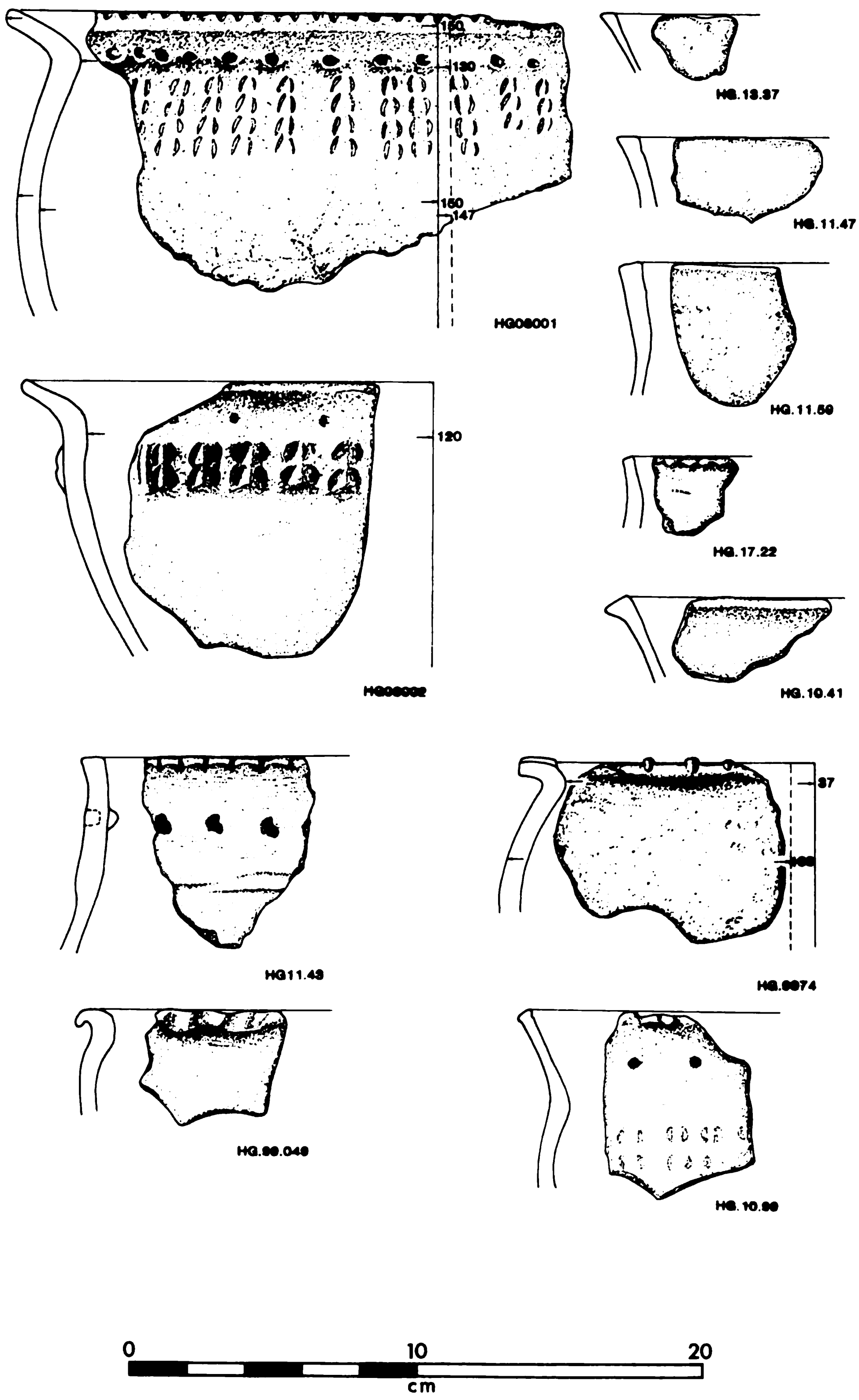

Fig. 5. Sherds from Hoghoi site; Sherds HG08001, HG08002, HG9074, HG.99.049 and HG.10.96 are of Gharanga type; sherd HG.11.43 is of Kopo type; plain lip sherds HG.13.37, HG.11.47, HG.11.59 and HG.10.41 have quartz-calcite hybrid temper; HG.17.22 has a non-placer volcanic lithic-calcite temper.

The Honiavasa assemblage can be classified as late rather than early in the Lapita ceramic series by: the absence of flat bases and stand bases, the absence of fine dentate stamping with filled motifs, the absence of rouletting, and the presence in low frequency of coarse dentate in open linear motifs, as well as the presence of two examples of Lasigi "class 2 modification" (Golson 1992) or scalloped method (a) rims (White and Downie 1980:Fig. 8i–k).

A number of Roviana intertidal sites fall within what could be called the post-Lapita period of the sequence, where vessel forms are predominantly round bottomed and round-to-hard shouldered with fairly vertical sides, slightly restricted necks and tall, everted, mainly excurvate rims (Fig. 4). Linear incised rims without zone-marking bands are common (commonly Mead motif M18.2), often with some applied decoration also. Typically on these rims there is a band of opposed pinch fingernail impression at the neck and commonly an unfilled band of unbounded zigzag incision on the shoulder below the fingernail impression. Lips on plain rims frequently exhibit Lasigi class 2 modification (a horizontal wavy deformation), although spatial analysis in progress suggests this latter lip form tends to be differently distributed within sites in comparison with incised rims. This distributional difference may have a temporal implication. Rims for these two types mostly extend 30–70 mm above the apex of the neck with an exterior neck included angle of around 150 degrees. Notable departures from these types are sherds of exotic quartz-calcite temper with different incised patterns (Fig. 4:MH. 44 and MH. 185).

A minority of vessels with more elaborate appliqué exist within these post-Lapita assemblages, slightly reminiscent of some Lesu ceramic designs, with anthropoid or animal 'fingers' curling over the lip of the vessel, or elsewhere on the vessel (Reeve 1989:Fig. 4g; Sheppard et al. 1999b). These may be a late style, as they are found most commonly in the Paniavile assemblage, where pottery seems to have continued to have been deposited until at least 390 BC.

A minor component of sherds in sites of this general description are of the Gharanga type (Fig. 5), which typically occurs as two to four vessels per site assemblage, having a shorter, more everted rim, seldom over 20 mm in depth and sometimes less than 5 mm, usually decorated by a band of punctation at the neck and a stacked series of 2–4 bands of opposed pinch fingernail impression, or, if one considers an alternative sequence of application, a series of opposed pinch vertical bars. The neck angle is typically 80–140 degrees, as seen in some Kiki ware rims from Tikopia (Kirch and Yen 1982:196). A high tightly rounded shoulder is often present close to the neck, as in the vessel form illustrated from Anuta Layer III (Kirch and Rosendahl 1973:Fig. 14). Some vessels of this form are very thin-walled, and most are slightly smaller in their body dimensions than the Honiavasa or the 'post-Lapita' incised/applied pots. This type typically has placer volcanic temper of fine black sand dominated by opaque ferromagnesian minerals. A related style found in the same sites is a variant on this theme, called here 'Kopo type', with a taller, less everted (sometimes slightly inverted) rim, a band of punctation at the neck, without the repeated bands of aligned fingernail impression (Fig. 5:HG. 11.43). Gharanga and Kopo vessel forms may represent technological alternatives within a style, where a technical/functional dichotomy is engendered by the plastic limits of the clay: a rim formed in one piece with the pot can be either short and strongly everted, or tall and minimally everted. It is noted that the bands of fingernail impression occur frequently on the Gharanga type, but not on Kopo type vessels. These two types taken together may be evidence for the abandonment of slab-constructed complex Lapita-series forms by the end of the Roviana series and the persistence of a system of exclusively one-piece vessel construction.

Vessels of this form and decoration predominate in two major sites, Gharanga and Hoghoi. In contrast, this type is absent from the Honiavasa late-Lapita site, and occurs in low frequency in Miho, Zangana and Paniavile assemblages. I initially placed the Gharanga style of pottery at the late end of the intertidal sequence, after 390 BC (postdating the AMS charcoal date from a Paniavile plain body/shoulder sherd). A date has recently been obtained from a plain vessel in the Hoghoi site which casts doubt on this assignment of such a late date to the Gharanga style: the age-span of this style is unclear at present. While sherds of Gharanga type co-occur in the Hoghoi site with plain-lipped sherds and notched/scalloped sherds (the plain lips all having quartz-calcite exotic temper: Fig. 5:HG. 13.37, HG. 11.47, HG. 11.59, HG. 10.41), spatial separation of these styles within the Hoghoi site raises the possibility of temporal separation despite their co-occurrence within this site. Occasional sherds with this sort of decoration show up in a number of late-Lapita or post-Lapita reef and land sites in Near Oceania, and a fairly similar decorative motif and body form turns up in some quantity in post-Lapita contexts on Erromango in southern Vanuatu (Spriggs and Wickler 1989; Bedford et al. 1998; Bedford 1999), although the resemblance to the Vanuatu material may be coincidental.

Lithic style

Nine flaked and ground adzes or adze fragments were recovered, one of which, from the Zangana site, was of plano-lateral 'horsehoof' form, previously known only from Lapita sites (Green 1991). As this site has pottery similar in many respects to that of the Paniavile site, Reeves's (1989) hypothesis of a Lapita derivation for the Paniavile post-Lapita ceramics is strengthened.

Pottery transfers as indicated by ceramic fabric analysis

The Roviana intertidal assemblages comprise a very heterogeneous group of tempers. A stratified sample of 29 sherds from 3653 sherds examined in hand specimen was sent to William Dickinson (Arizona University) for petrographic examination. Four heterogenous volcanic groups were present, potentially representing a variety of sources within the New Georgia group, with one of these unlikely to come from anywhere closer than Vella Lavella, and potentially originating outside the New Georgia Group.

The fifth temper group comprised quartz-calcite hybrid temper sands, of beach origin, forming a homogenous group suggestive of origin on a single coastline. I paraphrase here from Dickinson's petrographic report (Dickinson 2000a):

> "The presence of both plagioclase and K-feldspar in variable but subordinate amounts was confirmed by staining, and suggests derivation of the terrigenous fraction of the sand from the weathering and erosion of intrusive granitic rocks. The common occurrence, in minor amounts, of epidote, which occurs as a deuteric or hydrothermal mineral within plutonic complexes, is broadly compatible with such a derivation... A plutonic complex somewhere within the Solomon Islands can be entertained as a marginally possible source, but derivation from the more continental setting of New Guinea ... is a more attractive possibility..."
>
> "The conclusion seems robust that they are exotic to the New Georgia Group ... They can be regarded provisionally as intrusive into New Georgia from an unknown locale, conceivably somewhere on the New Guinea mainland."

A working conclusion is that interaction within the New Georgia group, and at least as far as Choiseul / Ysabel, was occurring throughout the Roviana intertidal sequence, and that long-distance sea crossings to the Solomon Sea Islands or New Guinea mainland are a strong possibility given the likely geological origin for the quartz-calcite temper group, and the lack of similar fabrics in the ceramic sites of the Bismarck Archipelago (Dickinson 1998, 2000b).

The Roviana quartz-calcite temper is distinguished from Kreslo "light" fabrics (Summerhayes 2000:144) by complete absence in the former of any volcanic minerals or lithic fragments of volcanic origin, which are present in quantity in the latter. Such pure quartz sands lacking a volcanic component would be expected only from a continental coastline where there are large exposures of exclusively granitic rocks in the hinterland, or from the beaches of a granitic island where volcanic rocks were absent. Plutonic intrusions in the Bismarck Archipelago and the Solomon Islands that might produce quartz-rich temper sands are thought to be too localised to produce sands devoid of traces of volcanism, and would be expected to produce combined quartzose-volcanic tempers, as observed in the quartzose tempers from the Watom and Kreslo assemblages.

Significance of Kaliquongu site distribution for inferring the distribution of Early Lapita in the Near Oceanic Solomon Islands

One outcome of the 1997 intertidal survey is the extension of the Roviana sequence back to the Lapita ceramic series as a direct result of more intensive survey within a very small portion of the New Georgia group. The one reef passage that has been intensively surveyed *intertidally* on New Georgia has yielded a 100% hit rate for Lapita occupation. Only four of the 40 or so reef passages that encircle the New Georgia mainland, location types favoured by Lapita sites elsewhere, were surveyed at all in the present study, and only one of these was intensively and systematically surveyed *intertidally* during the survey of the Kaliquongu area, with two further shallow reef passages partially surveyed in this manner.

The results of the 1997 survey are interpreted as suggesting that post-Lapita intertidal occupation of the Lagoon was more widespread and populous than late-Lapita occupation. This is a hypothesis clearly in need of testing by further survey and refinement of chrono-stylistic studies, as the sample of sites is very small and present notions of the chronological implications of the various ceramic styles in this discussion are rudimentary. The 1997–1998 intertidal survey area yielded six major ceramic sites, one late Lapita and five post-Lapita, as well as a number of smaller ceramic scatters, aceramic scatters of lithic manuports, and find spots of single sherds. This suggests that late-Lapita intertidal occupation sites were more rare than post-Lapita occupation sites in the past, and by projection of this trend into the unrecovered past, that early-Lapita sites, if present, would be even less common than late-Lapita sites. If on the basis of the late-Lapita result we would expect about 40 late-Lapita occupation sites around New Georgia's reef passages, then it seems likely, on the present intertidal survey results, that a scatter of early-Lapita sites could be expected around New Georgia in the intertidal locations not yet surveyed.

The area surveyed in 1997–1998 comprises roughly 100 sq km (land and sea) or less than one per cent of the total area of the New Georgia Group of islands which has an area around 11,000 sq km (excluding from this figure the larger water areas of the Blanche Channel, the Kula Gulf and the Vella Gulf). The results in hand, however inadequate for drawing any final conclusions, are the only results for the Solomon Islands bearing on the question of intertidal early-Lapita occupation. If these results are representative of the remainder of the coastlines of the Western Province (which seems likely for at least some areas based on brief reconnaissance of Marovo Lagoon in 1997 by Roga and Sheppard) (Sheppard pers. comm.), they strongly suggest that early Lapita was present somewhere in this region.

These data add support to the view that the lack of early-Lapita sites in the Near Oceanic Solomon Islands is an artefact of insufficient intensive coastal and *intertidal* survey rather than their complete absence. Although early-Lapita sites were not found, only the later and more common end of the Roviana ceramic series was found during the first two field seasons of the New Georgia archaeological survey. The finding of the late-Lapita Honiavasa site, only after considerable survey within a small area during the 1997–1998 intertidal survey, suggests that classic or early Lapita, if it is there, is likely to be more rare than sites like Honiavasa and will probably only be found using highly targeted survey methods pitched at a broader spatial scale than that study. Based on the 1996–1998 Roviana intertidal survey results, as the sample of survey coverage increases, it is likely that hitherto undiscovered variation will continue to be added to the New Georgia ceramic sequence. Only when this trend can be seen to be tailing off can we infer that most of the ceramic variation out there has been sampled. We are clearly not yet in that state of sampling saturation.

It is suggested that the fragile nature of intertidal sites, as estimated by the study of Roviana vessel completeness, may be relevant to understanding intertidal sites elsewhere in the Near Oceanic Solomon Islands. Based on the results of the Roviana study, emergent coastlines should not be expected to preserve uplifted intertidal sites. The poor state of preservation of sherds found in the vicinity of the high-water strand line suggests that emergence will largely destroy the stylistic evidence from such sites, even if some small sherds survive. Only in the case of prior progradation of soft sediments along a low-energy shoreline might intertidal sites be expected to survive a fall in relative sea level. If early-Lapita pottery was typically deposited as the refuse from occupation over the intertidal zone in the broader region, the absence from both terrestrial and intertidal survey of anything identifiable as a Lapita site would not necessarily imply absence of such occupation in the past.

Conclusions

New ceramic data from the 1997–1998 field seasons suggest earlier ceramic sites in Roviana Lagoon than was first thought, with ceramics from the Honiavasa site and Nusa Roviana being more similar to early Lapita than those found in 1996. This new data refocuses attention on the question of whether early Lapita is present in the area. The intertidal location of Roviana ceramic/lithic scatters, taken together with the discovery, during the Lapita Homeland Project and more recently, of a number of similar sites in Near Oceania, suggests that archaeologists working in the region with an interest in the distribution of Lapita and post-Lapita pottery need to take intertidal archaeology seriously. The Roviana data are particularly noteworthy in this respect, as no significant ceramic sites of the Lapita and post-Lapita series were located on land.

Work in progress on the development of suitable archaeological methods for these site types has been sketched above. Present evidence favours the view that all of the Roviana intertidal sites originated as the refuse from settlements located over the intertidal zone, rather than through immersion of terrestrial sites following changes in sea level. Results of geomorphological work in progress as part of the New Georgia Archaeological Survey should provide an independent assessment of this conclusion.

Analysis of vessel completeness suggests a high degree of post-deposition sherd attrition. From this it can be concluded that:

1. Inferences regarding the intensity/duration of occupation cannot be based directly on observed sherd quantity, but instead must be based on an estimate of the quantity of pottery deposited in the past, using vessel completeness data.
2. The degree of sherd attrition evident in Roviana intertidal assemblages suggests these are a fragile type of archaeological deposit. The poor state of preservation of these sites in the favourable Roviana Lagoon environment suggests that the absence of such sites might be expected in less favourable preservation contexts, conceivably including much of the remainder of the Solomon Islands coastline. This assessment of the state of attrition in which Roviana intertidal sites exist today underpins the proposition that an intertidal Lapita settlement pattern may formerly have been the norm throughout the Near Oceanic Solomon Islands, and is preserved only in places like the extensive and tectonically stable sheltered lagoons that ring New Georgia (Dunkerly 1986:36–37). This could account for the gap in the distribution of early-Lapita pottery in this region. Future survey along other comparably sheltered, stable coasts of the Solomon Islands can test this proposition.

AMS radiocarbon dating suggests a minimum intertidal sequence from 600 BC to 390 BC, but on stylistic grounds this can probably be extended, particularly at the early end of the sequence, to include the (probably undated) late-Lapita component of the series. The stylistic sequence begins on present evidence with late Lapita, which was identified by the high frequency of complex vessel shapes and low frequency of coarse dentate stamping, but absence of flat-based excurvate-rimmed bowls and vessel stands. Post-Lapita ceramics include mainly globular-bodied, excurvate-rimmed vessels, which are frequently incised/applied, and often have a band of opposed-pinch fingernail impression around the neck. Rare round-based open bowls are present in post-Lapita assemblages. A plain ware with horizontally waved lip appears in varying frequency in most sites, and the chronology of this style is at present uncertain. The same can be said of a set of punctate/applied decorated wares, commonly with short, heavily excurvate rims and a matrix of opposed-pinch fingernail impression below the neck. The presence of at least one plano-convex adze in the small assemblage of lithic artefacts also suggests Lapita affinity and the heritable continuity between Lapita and post-Lapita.

Pottery transfers seem to form a significant proportion of the assemblage, with most pottery composed of temper sands exotic to Roviana Lagoon. The characterisation of the pottery into four heterogenous volcanic groups and a fifth homogenous granitic-derived group, present in low frequency, suggests regular transfer of pottery at a variety of spatial scales throughout the Roviana ceramic series, from a variety of localities within the Western Province, and from at least one more exotic location, potentially as far away as continental New Guinea, suggesting possible interaction across the Solomon Sea. If this were so, it would be consistent with the implication of the presence of material of D'Entrecasteaux origin in the Reef / Santa Cruz Lapita sites (Green and Bird 1989).

It is entirely possible that early-Lapita sites were widely spaced across the landscape, although these were not found within the limits of the 1997–1998 intertidal survey. The vast majority of the New Georgia coastline remains unsurveyed, and there is little reason to suppose that the unsurveyed majority of New Georgia's lagoons have a lesser ceramic record. The potential for earlier Lapita sites for the New Georgia region requires a broad-scale targeted approach on appropriate locations before they are deemed absent, not present, rather than the current absent, not yet found.

It is hoped that what emerges most clearly from this paper is that the archaeology of New Georgia intertidal zone has not been 'done'. There are no firm conclusions to be drawn with confidence regarding the distributional history of Lapita occupation in the past from this initial, limited look at the intertidal archaeology of this area. The results in hand are useful in that they are not quite what might have been expected by many Lapita archaeologists. In terms of the possible explanations for the early-Lapita gap listed in the introduction, the explanation most favoured is an unusual one: that a pattern of intertidal settlement in the past has created the dual conditions of low site preservation / visibility and unexpected site location. Implicit in this proposition is a suggestion that early Lapita may have been continuously distributed across the Near Oceanic Solomon Islands in the past, as a shifting network of interacting settlements, located exclusively over the intertidal zone, of which we are likely to find only rare traces in settings favourable to their preservation. This proposed pattern can be tested archaeologically by conducting future survey in locations both favourable for the placement of such sites in the past and favourable for their preservation in the present. Such work could proceed in conjunction with conventional terrestrial surveys. It is to be hoped that 1997–1998 Kaliquongu intertidal survey becomes one in a series of surveys of this type which will in time contribute to the resolution of issues basic to the chronology and distribution of early Lapita and its derivatives in Near Oceania, and thus provide a more secure basis for inferences based on these theoretical constructs.

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The rise and rise of the incised and applied relief tradition: A review and reassessment

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Introduction

When scientific archaeology began in the Pacific during the 1950s and 1960s much of the research focused on the identification and characterisation of ceramic traditions. From the first scientific excavations a number of clearly different ceramic styles were recognised (Gifford 1951; Gifford and Shutler 1956; Golson 1959). By the mid-1960s Golson (1968:10) had tentatively outlined three principal ceramic traditions that were found in the region, namely Lapita ware, Paddle-decorated ware and appliqué and incised wares (i.e. Incised and Applied Relief Tradition). These traditions were seen as potentially representing separate prehistoric population dispersals, deriving from the west and reaching to the central Pacific. Lapita spanned the Melanesia–Polynesia ethnological divide and was seen at least in the more eastern part of its range as representing the founding population, which either pre-dated the Melanesian cultures, as for example in the case of New Caledonia, or was seen as ancestral to the Polynesian populations east of Fiji (Golson 1961; Green 1963). The Paddle-impressed and Incised and Applied Relief Traditions were interpreted as representing later arrivals from the west who had brought a non-Austronesian biological component to the southwest Pacific. It was within this initial paradigm that many of the subsequently excavated ceramics were arranged, albeit occasionally in a modified chronological sequence.

This early research focused on Lapita sites which have been an archaeological priority since. But the excavations of Specht on Buka (1969) and Garanger in Vanuatu (1972) began to reveal the rich diversity of the Applied and Incised Relief Tradition, which challenged the primacy of Lapita in the case of New Caledonia and Vanuatu. The Mangaasi tradition from central Vanuatu, a regional variant of the Incised and Applied Relief Tradition, was thought to be unrelated to Lapita and seemed to pre-date it in Vanuatu (Garanger 1972:124–125). Garanger found similarities between the Mangaasi tradition and ceramics from the Buka sequence as well as other Incised and Applied Relief traditions found in Fiji and New Caledonia. These tentative connections had also been suggested by earlier scholars such as MacLachlan (1939) and Avias (1950). Mangaasi-style ceramics were thought to originate from much further west, Garanger tentatively suggesting New Guinea and more specifically the Markham Valley area (Garanger 1972:124). He did, however, emphasise that it was a highly speculative connection at such an early stage of research. Specht also noted, again cautiously, a number of homologous ceramic traits between the Buka and Mangaasi sequences (Specht 1969:236).

The early excavations of Specht and Garanger generated widely adopted theories about the widespread and inter-connected nature of the Incised and Applied Relief Tradition (Golson 1972; Frimigacci 1981; Kennedy 1982; Kirch and Yen 1982; Spriggs 1984). It was identified from Wuvulu in the Admiralty Islands to Fiji and there were few who seriously questioned its legitimacy as an inter-related ceramic tradition (although see Reeve 1989:55 and Bulmer 1999:570). These assertions, despite having to rely heavily on the original results of Specht and Garanger, have continued to have considerable influence up to the present, with many of the earlier unmodified conclusions becoming incorporated into contemporary theory regarding colonisation, settlement and cultural transformation (Gosden et al. 1989; Spriggs 1990, 1993, 1997; Sand 1995; Galipaud 1996a, 1996b; Gorecki 1992, 1996; Green 1997; Wahome 1997, 1999). In the most detailed and wide-ranging study on post-Lapita ceramics, and the first to utilise a range of statistical methods to assess ceramic similarity, Wahome (1997, 1999) argued that the ceramic remains from the region demonstrated continued contacts between the regions of Island Melanesia from the Lapita period through to the post-Lapita period and right up to 800 BP, at which time increased regional diversification was evidenced.

Despite these claims, the Incised and Applied Relief Tradition remains, as it did more than 30 years ago, the least well known of the three traditions originally proposed by Golson (1968:10). Whilst Lapita now commands the attention of whole edited volumes and books and the paddle-impressed ware of New Caledonia has been interpreted as the domestic component of Lapita assemblages, the Incised and Applied Relief Tradition continues to be largely under-researched and the least well defined in terms of its stylistic definition, its distribution in space and time, and the human behaviour and cultural relationships it represents. Ceramic description has often been limited to the technique of decoration and categorising an assemblage as belonging to the Incised and Applied Relief Tradition which has often only simply enabled it to be delineated from a dentate-stamped or paddle-impressed assemblage. Assemblages attributed to the Incised and Applied Relief are often poorly provenanced and/or the decorated sherds are small or in poor condition, making it difficult to positively identify motifs or vessel forms as opposed to decorative technique.

More recent research in both Vanuatu and Fiji on the post-Lapita ceramic sequences has allowed a reassessment of the Incised and Applied Relief Tradition, certainly in terms of it representing a Melanesia-wide tradition demonstrating broadly synchronous change across the southwest Pacific. Greater chronological control and, particularly in the case of Vanuatu, a significant pottery sample from the first 1000 years of settlement have allowed much finer-grained comparison than has been possible to date. A broad range of criteria was used to assess the similarity of ceramic assemblages. The criteria included vessel form, decorative technique, motif form and associated chronological data. In many respects the ceramics from Vanuatu and Fiji have been seen in the past as representing respectively the core and the eastern periphery of the Incised and Applied Relief Tradition. It is in this order that the more recent results are presented.

Vanuatu: at the core of the Incised and Applied Relief Tradition

Recent excavations in Vanuatu (Bedford et al. 1998; Bedford 2000a, 2000b) have provided a series of detailed ceramic sequences from the inter-visible islands of Efate and Erromango, which has enabled a re-evaluation of earlier results and conclusions from that archipelago and from the broader region. The research has led to a major reassessment of the central Vanuatu ceramic sequence or Mangaasi tradition, originally proposed by Garanger (1972). No longer can it be seen as a sequence characterised by conservatism in vessel form and decoration, comprised predominantly of incised and applied relief, that appeared at around 2500 BP and continued for another 2000 years. Rather, the sequence, beginning around 3000 BP, is shown to be dynamic and changing throughout and follows a developmental trajectory from Lapita beginnings through to the later phases which terminated around 1200 BP.

The ceramic remains from Erromango parallel those from Efate in two aspects, namely the primacy of Lapita and the continuity of the sequence, but that is where the similarities begin and end. A brief outline (see Bedford 2000b for a more detailed description and definition) and comparison of the ceramic sequences from these two islands are required to further demonstrate the distinct ceramic trajectories.

Efate and Erromango ceramics 3000–2800 BP

Ceramics on both islands first appear around 3000 years ago and are associated with the arrival of Lapita colonists. On Erromango this is best demonstrated at the site of Ifo located on the southeast coast of the island where calcareous-tempered dentate-stamped and incised sherds were recovered from the lowest cultural layer of the site (Fig. 1). The limited number of decorated sherds and rims restricts definition of vessel forms and design motifs. Plain globular cooking vessels with out-curving rims were identified as a component of this phase of the ceramic sequence. The Lapita Phase was short-lived, appearing around 3000 BP and dropping out by 2800 BP. This appears to parallel the situation on Efate. Dentate-stamped sherds have thus far been recovered only from the stratigraphically mixed Erueti site, but recent excavations at the Arapus site, directly southwest of the Mangaasi site, have enabled the identification of a distinct vessel form associated with the Lapita settlement of Efate representing the cooking component of the assemblage (Bedford and Spriggs 2000). It indicates that there were distinct activity areas at the site, with the location of the ceremonial and / or high status dentate-stamped pottery yet to be found. The earliest pottery at the Arapus site has been dated to ca. 3000 BP and is characterised by globular pots with out-curving rims, and frequent lip notching (Fig. 2a). This phase on Efate again appears to have been short-lived, perhaps in the order of 100–200 years. By 2800 BP the out-curving rims became increasingly horizontal and developed into the distinctive wide, flat lips which characterise the Erueti style plain ware vessels (Fig. 2b).

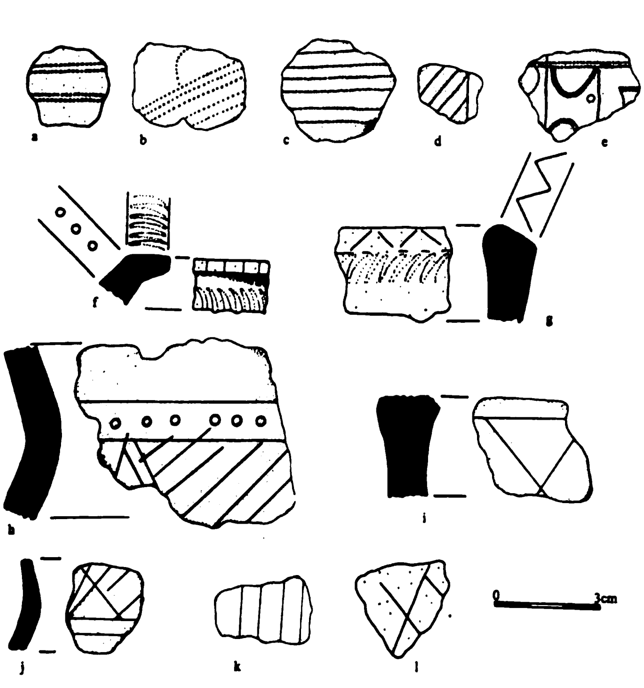

Fig. 1. Lapita dentate-stamped (a-g) and incised sherds from Ifo, Erromango.

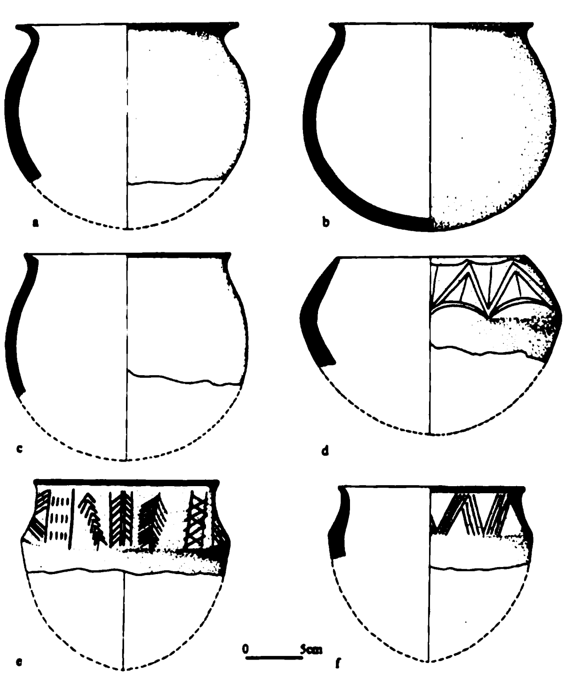

Fig. 2. Arapus ware (a) and Early Erueti Ware (plain b, c and decorated d-f).

Efate and Erromango ceramics 2800–2500 BP

The Erueti phase of the ceramic sequence on Efate, originally identified by Garanger at the Erueti site (1971), can now be divided into an Early and a Late phase. The Early Erueti Phase appeared around 2800 BP and was characterised by a variety of vessel forms, dominated by plain out-curving rim vessels with wide, flat lips, which were almost always notched on the lip exterior (Fig. 2b,c). Other rarer decorated vessel forms were present and might be seen as representing the ceremonial component of the assemblage (Fig. 2d–f, 3). Small cups, possibly associated with *kava* consumption, were also associated with the Early Erueti Phase (Fig. 3j,k,q). Decoration on the Early Erueti Phase ceramics consisted exclusively of incised motifs and notching on the lip. Punctation was identified only on the horizontal surface of the wide, flat lips. There was no applied relief or fingernail decoration associated with this phase of the sequence. A number of quite complex and varied incised motifs were also identified (Fig. 2d–f). It can be argued that several vessel forms and motifs have generic Lapita connections (cf. Fig. 2d,f). Handles of a single form were present but rare.

At the same time on Erromango (from 2800 BP) a distinctive plain ware phase (named the Ponamla Phase) was developing. Vessel form was largely restricted to globular out-curving rim vessels (Fig. 4a–e) with decoration restricted to occasional lip notching. Again this appears to have been a short-lived phase which was transformed around 2600 BP by the appearance of a multitude of largely fingernail-impressed motifs (Early Ifo Phase). The greatly increased number of decorated sherds and the wide variety of motifs initially appeared on identical vessel forms to those of the earlier phase (Figs. 4, 5). Plain ware vessels continued as a component of the ceramic repertoire. Notching on the lip remained a rare decorative technique as in the earlier plain ware phase. A total of 35 separate design motifs have been identified, 24 of which are composed of fingernail decoration. Much rarer were incised sherds and associated identifiable design motifs, but two in particular demonstrate close affinity to Lapita motifs (Fig. 5g,m; compare with Anson motifs 175, 318 and 369). One of these motifs (Fig. 5m) also featured amongst the early post-Lapita motifs recovered from Efate. This material initially appeared around 2600 BP and continued for several hundred years or so, transforming into a distinctive new style from 2400 BP (Late Ifo Phase).

By around 500–600 years after initial settlement on the two islands it can be seen that the ceramic sequences are well on the way to independent trajectories. They continue to further diverge as the sequences progress through time. On Efate by 2500 BP a perceptible change in the ceramic assemblage, in terms of both vessel form and decoration, can be identified. It is at this point that a Late Erueti Phase is proposed. Out-curving rim vessels became much less frequent or disappeared to be replaced by in-curving rim vessels (Fig. 6). Carinated vessels became increasingly globular (Fig. 6e,i). Decoration was still largely restricted to incision (Fig. 6), and became more frequent, suggesting that the proposed distinction between plain utilitarian vessels and decorated ceremonial vessels was beginning to fade. Notching of the lip remained a regular decorative feature. Certain motifs identified in the Early Erueti Phase assemblages continued through into this Late Erueti Phase and a number could be argued to have some affinity with Lapita motifs (e.g. Fig. 6j). Small cups were also still present.

By this date on Erromango (ca. 2400 BP) some simplification in vessel form can be seen, with out-curving rims being replaced by in-curving rims on vessels which tended to have thicker walls and were possibly less highly fired. Decoration became increasingly common during this phase, and it was still dominated by design motifs created with fingernail impression (Fig. 7). Some continuation in motif form can be demonstrated, as eight of the fifteen identified motifs from this phase of the sequence were also present in the earlier phase. The end of the ceramic sequence on Erromango occurred no later than 2000 BP. Vessels associated with the end of the ceramic tradition on Erromango were thicker-walled and display a number of distinct motifs, often in association with lip notching (Fig. 7l–o).

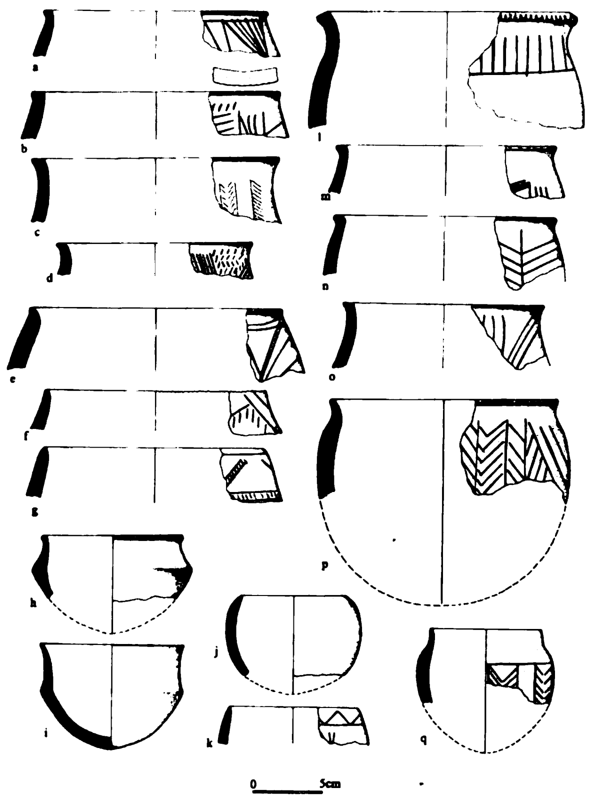

Fig. 3. Early Erueti ware ca. 2800–2500 BP.

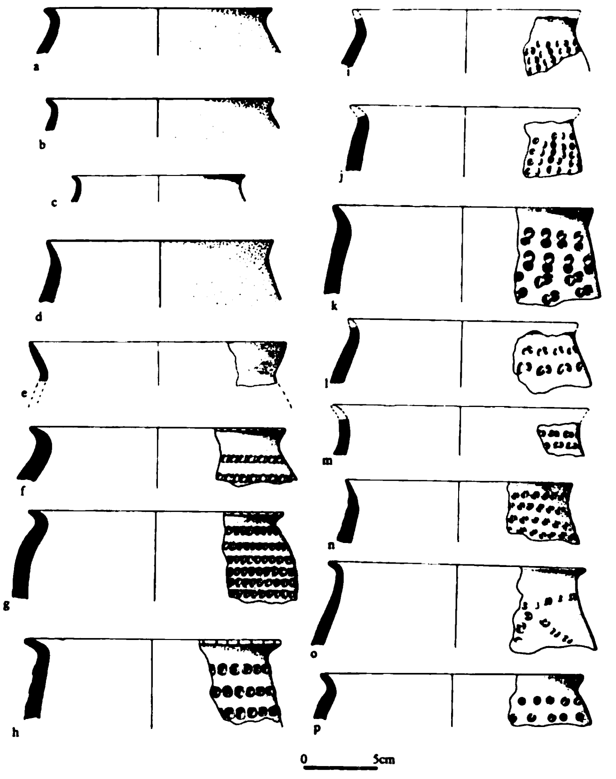

Fig. 4. Ponamla ware (a-d) ca. 2800–2600 BP and Early Ifo ware (e-p) ca. 2600–2400 BP.

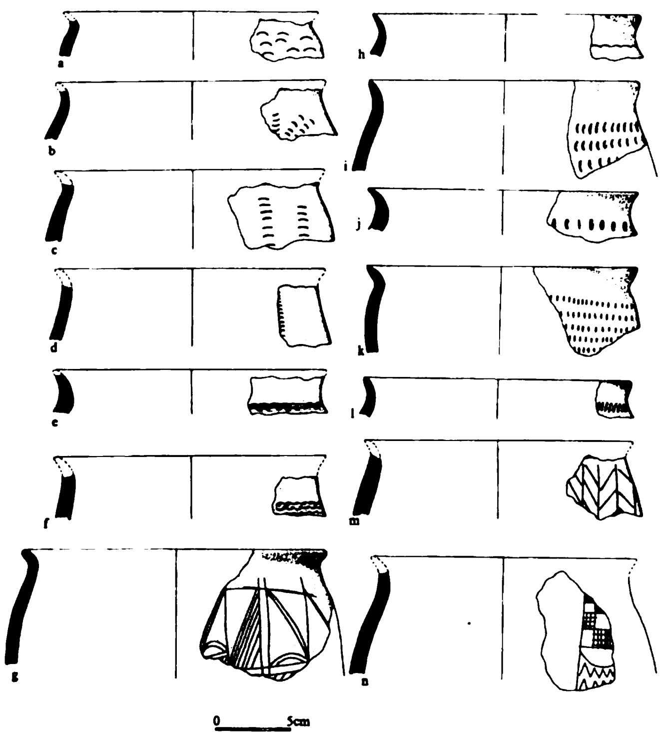

Fig. 5. Early Ifo ware ca. 2600–2400 BP.

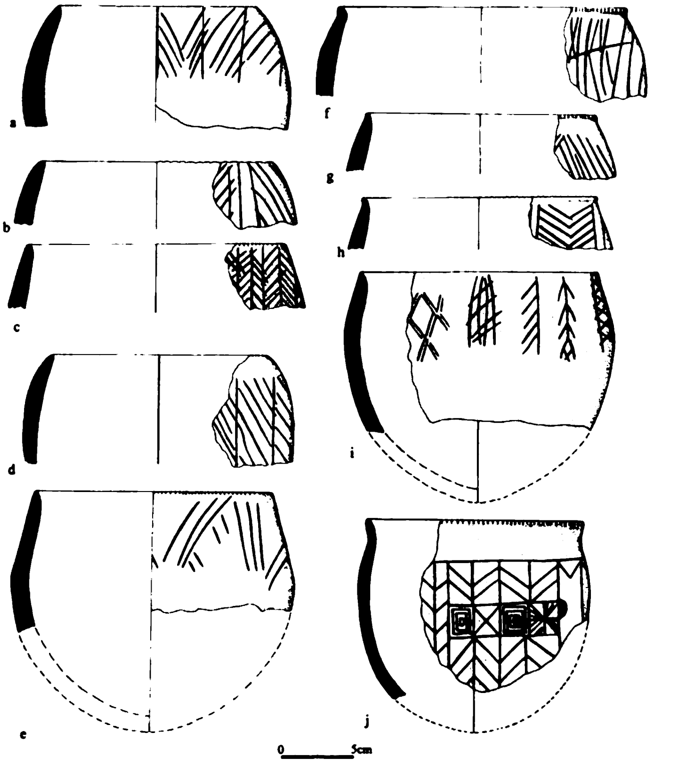

Fig. 6. Late Erueti ware ca. 2500–2000 BP.

Efate and Erromango ceramics 2000–1200 BP

So while ceramics disappear from Erromango around 2000 BP, the picture on Efate is quite different. This period is when the elements associated with Garanger's original Mangaasi tradition first begin to appear. It has been divided into an Early and a Late phase with the Early phase beginning about 2000 BP. The Early Mangaasi Phase was completely dominated by in-curving globular vessels (Figs. 8, 9). Small cups continued to be associated with this phase of the sequence (Fig. 8l,m). Decorative techniques associated with the Early Mangaasi Phase covered a wide spectrum and there was great variation through the sequence as well as in motif structure, but initially it appears that decoration predominantly consisted of incision (linear, geometric and gashes) and to a lesser extent punctation, utilised separately rather than in combination. Lip notching, which was a distinctive modal decorative attribute in the Erueti Phases, was no longer in evidence. Motifs became increasingly complex over time, with the various techniques and motifs being combined (Fig. 9). Discontinuous applied relief always appeared to be associated with already established motifs (Figs. 9e–h) that have generic connections to earlier forms, suggesting the discontinuous applied relief might represent a slightly later expansion of the motif repertoire. Again certain motif forms or design elements can be seen as providing continuity from earlier phases of the sequence. Continuous applied plain and pinched bands (Garanger 1972:Fig. 128; Fig. 9o) also made an appearance during this phase although these techniques were relatively rare. The applied bands appear to replace the oblique-parallel incision used to form a similar triangular motif. The applied triangle motifs were infilled by a number of other decorative techniques including punctation and geometric incision. Important to note is that these bands were not notched. This latter attribute became a distinctive feature only during the Late Mangaasi Phase.

Only a limited number of handles were recovered from the recent excavations at Mangaasi but they are supplemented with the forms illustrated by Garanger (1972:Fig. 134). Of those that were attached to vessels, all appeared to be associated with globular in-curving vessels and with a number of motifs that were exclusively associated with this phase of the sequence.

The Late Mangaasi Phase dating from 1600 BP was characterised by the reappearance of a variant of the earlier out-curving rim vessel (Fig. 10) which was first seen some 1500 years previously during the Lapita Phase. The vessels were decorated with a multitude of techniques in combination, although discontinuous applied relief and handles appear to be absent. Notched applied bands were a modal attribute of this phase of the sequence. This last phase of the sequence is best represented by sherds recovered by Garanger from his excavations and surface collections. A whole host of motifs can be identified which were not recovered from the recent excavations at Mangaasi, but these can, on the whole, be reliably placed within the Late Mangaasi Phase due to the distinctiveness of the decorative techniques and vessel forms. On current evidence ceramic production ceased on Efate around 1200 BP.

The ceramics from all the sites were made at, or near, the sites from which they were recovered and they demonstrate continuity of the sequence on these two islands from Lapita to the later wares. Although it can be seen from the presence of Lapita dentate-stamped ceramics, along with a number of immediately post-Lapita incised designs, that initial settlement of the two islands was part of a widespread colonisation of the region by members of the Lapita Cultural Complex, whatever connections this might have initially represented appear to have been short-lived. Dramatically demonstrated is the rather sudden development of island-specific ceramic styles displaying quite distinct and unique design motifs.

Although the ceramics from Erromango were initially described as a regional variant of Mangaasi (Spriggs and Wickler 1989) and later as having clear parallels with Mangaasi (Bedford 1999), the further detailed analysis of the Erromango sherds, along with the re-excavation of the Mangaasi site, have shown these earlier assertions can no longer be supported. The revised central Vanuatu sequence has also been compared in some detail to other ceramic sequences that investigators originally claimed had some sort of connection, in terms of homologous ceramic traits, to the Mangaasi tradition, as originally outlined by Garanger. Those claimed links can now also be shown to be less than secure

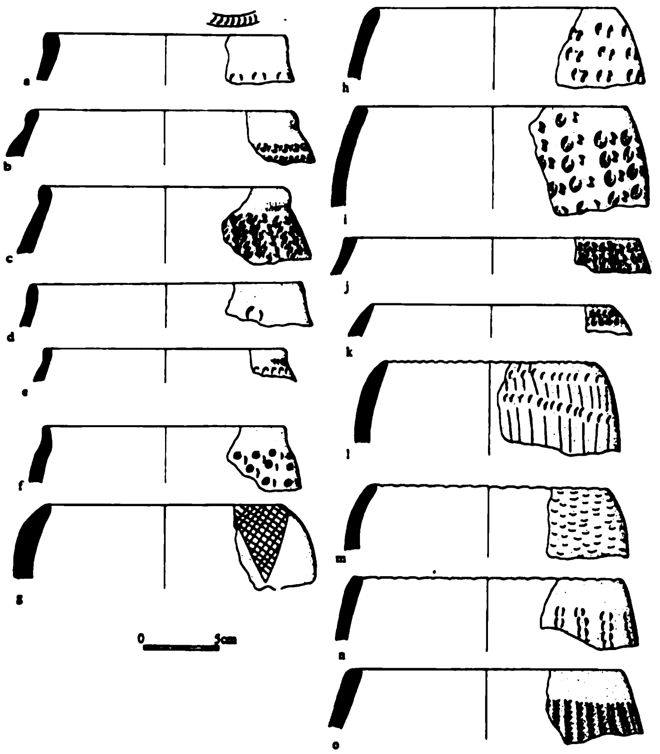

Fig. 7. Late Ifo ware ca. 2400–2000 BP.

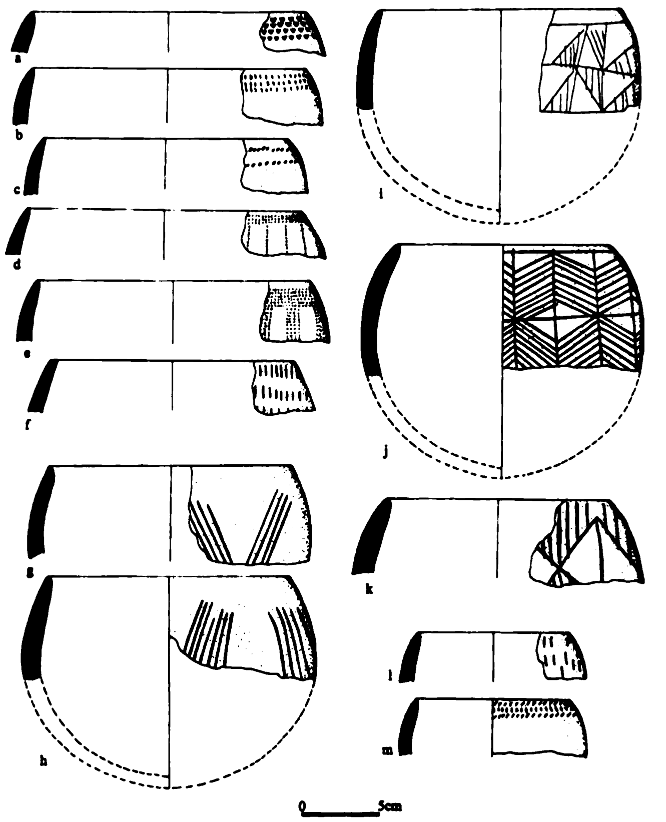

Fig. 8. Early Mangaasi ware ca. 2000–1600 BP.

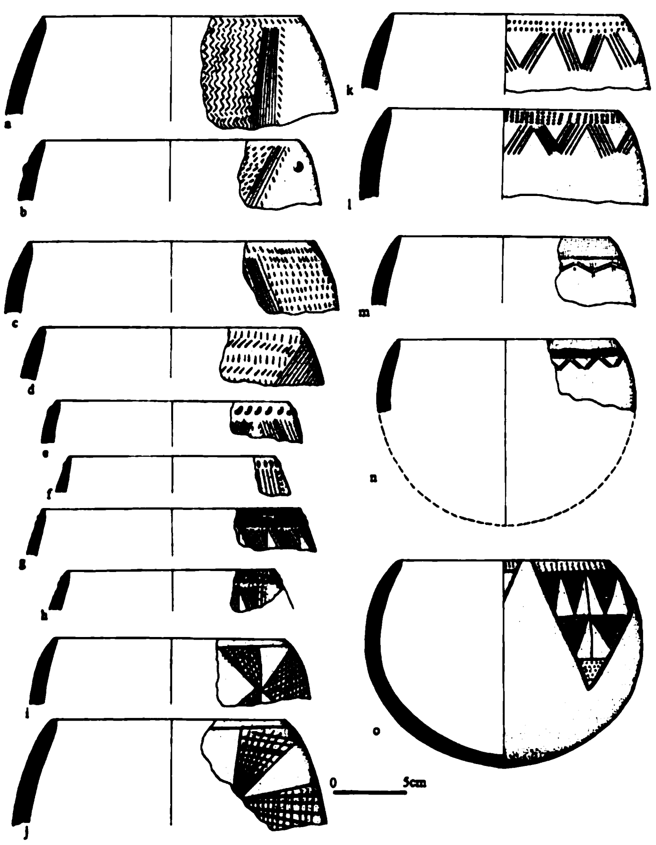

Fig. 9. Early Mangaasi ware ca. 2000–1600 BP.

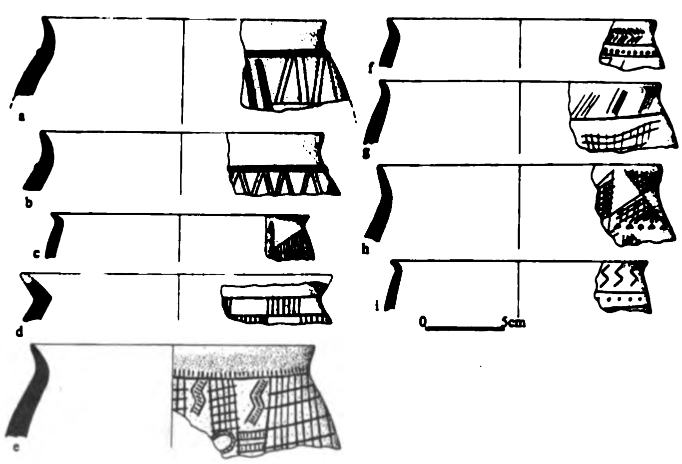

Fig. 10. Late Mangaasi ware ca. 1600–1200 BP.

(Bedford 2000b). It was these revelations that further encouraged the authors to reassess the validity of the widely accepted concept of an Incised and Applied Relief Tradition that could be identified across the southwest Pacific and which underwent some form of synchronous change indicating continuing interaction and inter-archipelago communication (Spriggs 1984, 1997; Wahome 1997, 1999).

Fiji: Incised and Applied Relief at the periphery

Evidence for contact between Fiji and island groups to the west, particularly Vanuatu, New Caledonia and the Solomon Islands, was not explicit in oral traditions nor mentioned in the accounts of the first explorers and missionaries. However, claimed links between Vanuatu and Fiji based on the similarity of their ceramics has a lengthy history (Garanger 1966:76; Gifford 1951:236; MacLachlan 1939:54; Surridge 1944:21–22), although with occasional dissent (Palmer 1971:83), and the idea has continued to be a pervasive theme in interpretations of Fiji's prehistory (Best 1984:493; Frost 1979:79). In fact the idea that the pottery of Fiji and Vanuatu belonged to a single Melanesian-wide pottery tradition, that later became known as the Incised and Applied Relief Tradition, was put forward as early as 1930 by Margaret Schurig in a publication on the distribution of Pacific pottery *Die Südseetöpfere* (1930).

Early archaeological work seemed to support these connections, with parallel-rib and rare cross-hatch relief sherds from New Caledonia, comb-incised sherds from northern New Caledonia, the northern Solomons and New Guinea, and asymmetric incised designs from New Caledonia and Vanuatu (Golson 1972:568) being argued as having analogues with pottery from Fiji. Garanger (1971:58) linked the cord-impressed ceramics found on the Mele Plain on Efate in Vanuatu with two Fijian sherds impressed with woven fibre excavated from Navatu and perhaps over-enthusiastically claimed the Incised and Applied ware from Fiji was "exactly the same" as the pottery of Vanuatu (Garanger 1971:62).

The redating of the Vanuatu sequence and its further refinement in association with recent detailed research in Fiji (Clark 1999) now casts serious doubt on these assertions. The earliest claimed parallels (cf. Gifford 1951; MacLachlan 1939; Surridge 1944) relied solely, particularly in the case of Vanuatu, on comparison of either small numbers of poorly provenanced surface-collected sherds or modern pots collected prior to the establishment of ceramic sequences from either archipelago. Alleged similarities identified both then and more recently (Best 1984; Frost 1979) have been restricted largely to ceramics that can now be associated with the later part (post 1700 BP) of the Fiji sequence. All of the homologous ceramic traits claimed between Fiji and Vanuatu are restricted to broad parallels in decorative technique rather than any detailed comparison of motif or vessel form. When a wider range of pottery attributes and their chronological span is considered (i.e. comparison of an assemblage's characteristics, not only of the decorative technique), these parallels are revealed as less than secure.

Frost associated ceramics from the Vuda and Ra Phases dating from 850 BP with Mangaasi material, describing its appearance in Fiji as a Melanesian ceramic intrusion that could reasonably be attributed to a central Vanuatu source (Frost 1979:79). Decorative techniques associated with the Vuda Phase (ca. 900–450 BP) are characterised by a number of different paddle-impressed motifs and end-tool impression (Best 1984:293–295). However, paddle impression is to date unknown in Vanuatu and the illustrated end-tool impressed motifs of the Vuda Phase (Frost 1979:69) show little resemblance to any of the central Vanuatu motif forms. Apart from this clear variance in patterns of surface modification, both the Vuda and even more so the Ra Phase (450–200 BP) can now be shown to postdate ceramic manufacture on Efate and the central islands of Vanuatu.

Best has suggested that influence from Vanuatu was somewhat earlier at around 1700 BP during the Navatu Phase and that it potentially continued for some hundreds of years as indicated by the recovery in Fiji of basaltic glass from a Banks Islands source (see further discussion below). This, he argued, seemed to coincide with the appearance of three new ceramic decorative techniques. These new techniques were described as "asymmetric and fingernail incising and finger pinching, cord wrapped paddle impressing and rim notching" (Best 1984:493). Again, however, under closer scrutiny these decorative techniques can either be seen to have been utilised very differently or even were non-existent in the central Vanuatu sequence of the same period.

None of the Fijian motifs that utilised the fingernail as a decorative technique (Birks 1973:131–137; Clark 1999:125) have parallels with the central Vanuatu sequence where fingernail decoration was extremely rare and largely confined to pinched bands. Added to the disjunct nature of the sequences is rim notching which by the time it had appeared in Fiji had long disappeared from the decorative repertoire in central Vanuatu. Further to the clear dissimilarities between decorative techniques of the period is paddle impressing. This was a dominant decorative feature of the Navatu Phase in Fiji, and included parallel, cross-hatch, curvilinear and oval forms of relief marking. As noted above, all of these are currently unknown in Vanuatu.

Best himself warned against placing too much importance on the asymmetric incision or rim-notching techniques, arguing that they were hardly diagnostic enough to be of any significance, particularly over such long distances (1984). However, parallels with the cord-marked Mele sherds (Garanger 1971) were seen as more meaningful (Best 1984:493). It appears that even this potential connection can now be conclusively dismissed. The sherds recovered from Mele have now been identified as foreign to Vanuatu and as coming from the much earlier Japanese Jomon tradition (Dickinson et al. 1999). The Fijian cord-marked ceramics are of local manufacture (Best 1984:333–334). It is also clear that the vessel forms and motifs from Efate are unlike the paddle-impressed post-Lapita assemblages of Fiji (see Clark 1999 and Bedford 2000b).

Strong support for a post-Lapita Fiji–Vanuatu connection came from the sourcing of basaltic glass found in two Lakeban rock shelters to the Banks Island in Vanuatu (Best 1984). The age of the layers containing the flakes was estimated at between 1700 and 1200 BP, suggesting that the Fiji–Vanuatu contact could have lasted for up to five centuries, representing a significant period of long-distance interaction sufficient for the transfer of ceramic styles between archipelagos (Best 1984:494). However, the age at which these flakes were deposited is difficult to determine and a case can be made for a more recent deposition around 1200 to 900 BP — at the end of the post-Lapita period — and potentially representing interaction with Tikopia rather than direct contact with Vanuatu.

The four glass flakes from the Site 197 rock shelter were all found in Layer F1, containing loose and compact midden, charcoal and stones (Best 1984:65). Layer F1 was not directly dated although two determinations about 20 cm below F1 have median calibrated ages of 1600 cal BP (NZ 4588, 2070 ± 30 BP on shell and NZ 4592, 1720 ± 40 BP on charcoal), while a charcoal date in the layer above F1 is dated to 750 cal BP (NZ 4905, 870 ± 60 BP). It is clear that the flakes derive from a zone where the deposit dating to 1600–800 BP has been removed or compressed making an assessment of the flakes' age difficult. At the Site 2(b) rock shelter 800 m from Site 197, 10 basaltic glass flakes were excavated from Layers J1 and H. Layer J1 is dated by a shell determination to ca. 1000 cal BP (NZ 5182) while J2 below is dated to about 1300 cal BP (NZ 4903; all dates calibrated with CALIB 3.0.3A using conventions reported in Anderson and Clark 1999:32, with Conventional Ages recalculated by the Rafter Laboratory). Overall, there is little convincing evidence to say that the basaltic glass arrived on Lakeba at 1700 rather than 1200 cal BP or later as the single C14 result for Layer J1 might suggest (cf. Clark 2000). If the basaltic glass did arrive in Fiji at 1200 BP, then the period of contact between Fiji and Vanuatu probably occurred at a time when ceramics were no longer made in central Vanuatu. Further, recent excavations suggest that basaltic glass from the north was not circulated in either south or central Vanuatu, supporting the ceramic evidence of intra-archipelago differentiation.

It is worth noting that instead of direct procurement from northern Vanuatu it is possible that the Lakeba obsidian arrived via Tikopia. On Tikopia Kirch and Yen (1982:260) found a large number of volcanic glass flakes with specific gravities consistent with a Vanuatu origin, and a paddle-impressed sherd with a temper indicating an origin from northern Viti Levu (1982:202). The majority of the Tikopian flakes arrived within the last 1000 years, which is not inconsistent with the suggestion of a late arrival of Vanuatu glass in Fiji.

Discussion and conclusion

The idea of an Incised and Applied Relief Tradition existing across the southwest Pacific has, since its inception, been based more on conceptual grounds than empirical data. Mangaasi, the term which Garanger originally coined to define specifically only the ceramic assemblages of central Vanuatu, has evolved to become almost synonymous with the Incised and Applied Relief concept. Both terms have often simply been used to differentiate ceramics that were neither dentate stamped nor paddle impressed (see Bedford 2000b for a discussion of this). The implied stylistic unity of ceramics contained under the Incised and Applied Relief–Mangaasi rubric has been used to support the concept of a Melanesia-wide inter-connected ceramic tradition. With it has gone a tendency to lump collections together rather than highlight differences.

A comparison of common decorative techniques like incision or appliqué, without regard to vessel form, motif design, or firm chronological control, tends to support scenarios of widespread population migration and diffusion and such is the case with the Incised and Applied Relief Tradition. Excluding dentate stamping and paddle impression, the Incised and Applied Relief Tradition could, if taken to its stylistic limit, encapsulate nearly all of the remaining ceramics from the western Pacific and to a lesser extent Fiji. But the act of grouping pottery using nebulous and common decorative techniques does not mean that a high degree of interaction need have existed between the pottery makers who included various kinds of incised and applied relief amongst their decorative repertoire, and this is the point we wish to emphasise.

Certainly in the very earliest stages of many ceramic sequences from the southwest Pacific similar changes can be identified. For instance, there is a change from the first dentate-stamped decorative wares to an increasing percentage of incised wares or plain wares, along with a decrease in the range of vessel forms. A few immediately post-Lapita motifs, decorative methods and vessel forms share a degree of similarity across sequences, but these might equally be explained as continuities from the founding ceramic tradition rather than continued inter-archipelago contact.

The relatively homogeneous nature of Lapita ceramics can be seen at least in part as the result of the frequent interactions between a small, widely dispersed and highly mobile colonising population (Graves et al. 1990:228; Summerhayes 2000) or at least as a by-product of a recent common ancestry. But if ceramic assemblages begin to show island-specific variation within an archipelago soon after Lapita settlement, as seen in Vanuatu, there are clearly other processes influencing the form and composition of those sequences. Rapidly changing population dynamics in association with changing environmental conditions might partly explain the diversification in ceramic styles which were reflecting efforts to produce and maintain geographically based social distinctions (Graves et al. 1990:228). In line with this idea there is now mounting evidence that the ceramic sequences of Remote Oceania began to follow increasingly independent trajectories soon after initial Lapita settlement and up until 1000 BP (Bedford 2000; Clark 1999).

The concept of a Melanesia-wide Incised and Applied Relief Tradition was useful during the infancy of archaeological research in the region but, as new evidence has revealed, it is no longer strongly supported by the data. The term and its implications have begun to cloud the archaeological picture and have led to simplistic explanations of cultural change increasingly removed from the central substantive issue, which is the degree of similarity or dissimilarity in the post-Lapita assemblages of Near and Remote Oceania. Our conclusion is that when large samples from well-dated and secure archaeological contexts are examined, the degree of similarity is not remotely close to that found in the Lapita ceramic series, which, it must be emphasised, was not in itself totally homogenous across time and space.

That is not to say that the study of post-Lapita pottery should be abandoned because inter-regional links might not be evidenced in the ceramic record. Rather, a different type of question needs to be asked. One of the most important questions in Pacific archaeology and anthropology is the origin of the significant human diversity of Island Melanesia compared with the lesser diversity found in Polynesia. Mapping the origins of the west-to-east clinal distribution in human variation from each archipelago's Lapita base is a field where the study of post-Lapita ceramics, along with other categories of archaeological, biological and linguistic data, will make an important contribution. However, this means that archaeologists need to reassess the post-Lapita record by tracking detailed patterns of stylistic variation within each archipelago, rather than making connections between island groups on the basis of individual ceramic traits.

These initial findings do not preclude the possibility that future research might well reveal low levels of inter-archipelago contact in the post-Lapita period and considerably higher rates during the last 1000 or so years. In addition, it is necessary to establish detailed post-Lapita sequences in the Bismarck Archipelago and northern Vanuatu which are areas still poorly understood compared with much of Remote Oceania. With these caveats entered, current ceramic evidence leads us to conclude that pottery styles primarily result from regional and archipelago processes and, in the post-Lapita period, are not synchronised over the western and central Pacific. However, it has been pointed out that ceramics, particularly utilitarian wares manufactured under household production modes, will probably not record inter-archipelago interaction at low levels, so it is imperative to examine other artefact categories, such as stone adzes, to gauge the nature and extent of post-Lapita interaction (Clark 1999:252). However, even if the post-Lapita ceramics from northern Vanuatu were eventually shown to be similar to those from Fiji — a speculation which is currently untestable, and indeed which could be made about any island or region where the ceramic sequence is unknown — it need not indicate a pan-Melanesian contact sphere of the scale previously attributed to the Incised and Applied and Relief Tradition.

Emerging results from Vanuatu and Fiji suggest a greater frequency of long-distance contact in the recent past, for instance in Vanuatu where some non-ceramic artefact forms point to increased long-distance interaction. Examples include the presence of Banks Island basaltic glass in Tikopia and Fiji, the widespread occurrence of *Terebra* shell and lenticular stone adzes across Vanuatu (and much of the southwest Pacific), New Caledonian serpentine on Tanna and Polynesian-style ornaments and burial practices in the central and southern islands of Vanuatu. Increased long-distance contact has also been recorded in the case of Fiji, where on Tonga, Tuvalu, Tokelau, Rotuma, and Tikopia Fijian pottery has been found in contexts dating from about 1200 BP on. Like the distribution of Samoan adzes recorded by Best and others (Best et al. 1992), the distribution of Fijian pottery crosses the ethnological zones of Melanesia, Polynesia and Micronesia and suggests the dimensions of interaction were expanding in the last 1000 years compared with the previous post-Lapita period. These data indicate that a significant portion of the cultural diversity in Oceania recorded at European contact could derive from the higher frequency of inter-archipelago contact taking place in the last 1000 years.

For this whole issue to be more adequately addressed there is a crucial need for the excavation and detailed study of well-dated ceramic sequences post-dating Lapita. As stated by Kirch and Yen almost 20 years ago, the nature and definition of post-Lapita sequences in the southwest Pacific remains "a major research concern with significant implications for the origins of ethnic diversity in the region" (Kirch and Yen 1982:202). As a research concern it would seem even more pertinent now that Lapita-style dentate-stamped ceramics are known to comprise at the most only the first few hundred years of most ceramic sequences in the region (Anderson and Clark 1999; Bedford et al. 1998; Burley et al. 1999; Sand 1997; Specht and Gosden 1997).

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6

Changes in non-ceramic artefacts during the prehistory of New Caledonia

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Introduction

When R.C. Green and J.S. Mitchell put together their 1983 paper on the archaeological sequence for New Caledonia in the *New Zealand Journal of Archaeology* they focused their study on the ceramic evolutions identifiable from the excavations made at that time. In the last part of the conclusion half a page was dedicated to the non-ceramic material (Green and Mitchell 1983:64). The authors could only note that "remarkably few non-pottery portable artefacts have been recovered archaeologically in New Caledonia", concluding that "...the overall pattern is fairly clear: ...artefact forms ... have changed very little in the last three and a half thousand years, despite changes in the styles of pottery decoration". A few lines later, they identified as one of the many subjects of pressing investigation "excavations of a kind that would greatly enlarge the corpus of structural and portable artefact evidence other than pottery for the Oundjo horizon" (ibid:64).

Since its creation 10 years ago, the local Department of Archaeology of New Caledonia has tried to focus its surveys and excavations to obtaining a better definition of the cultural evolutions occurring over almost 3000 years of prehistory. The first step was to enlarge our studies on items other than pottery, although ceramics still remain our best chronological marker (Sand 1998a). This approach has led to the building up of programs on landscape transformations (Sand 1999a; see also Stevenson 1998) and on settlement patterns (Sand and Ouetcho 1993a; Sand 1997b, Sand In press a; see also Guillaud and Forestier 1997), with the excavation or re-excavation of early as well as many late prehistoric sites, on the Grande Terre and in the Loyalty Islands (Sand 1998b). Faced with the problem of poor recording, in previous excavations, of the economic data, we have focused part of our attention on the fine dry and wet sieving of our sediments, first with the idea of recovering as much bone material and shell material as possible. This attention to the screened sediments has also led to the recovery of a vast amount of non-ceramic material. After an initial period of surprise about the variety of unsuspected remains, in an archipelago where non-pottery artefacts were said to have been "remarkably few", we have slowly built up a catalogue of these archaeological objects. The definition of the time periods of these items has been greatly helped by the running of more than 150 new C14 dates, some by AMS, allowing a more precise chronology (Sand 1996b, 1997a).

The scope of this paper is to attempt a more detailed and organised listing of the chronological evolution of the major non-ceramic items than was published as part of my PhD dissertation (Sand 1994a, 1995a) and briefly presented in an *Archaeology in Oceania* article (1996b). The organisation of the data has been more difficult than expected, as I have not found in the literature any similar type of publication listing different items over such a long period. As a preliminary trial for this paper, I have, though, tried to enumerate the evolutions visible in the major categories of non-ceramic artefacts, which is hopefully an advance on previous formulations. Presentation of these items will follow the general chronological divisions identified in the ceramic periods of New Caledonia.

Three potential biases need to be outlined first. The first concerns the differences in environments between the Grande Terre and the Loyalty Islands (Fig. 1). The Grande Terre is a continental landmass, composed of complex geological formations, with marked differences between coastal lowlands, deep valleys and high mountainous interiors. The Loyalty Islands are low coral formations, with the sea always at an easy distance. The second bias concerns the number of sites excavated for each period and the size of the excavations. The Lapita sites, which have a time length of only about a tenth of the total sequence (Sand 2000a), have been the most intensively and largest sites excavated to date. Sites from the first millennium AD are so far the least excavated and remain poorly known (Galipaud 1988a; Sand and Ouetcho 1993b; Sand 1994b). Finally, the situation for sites of the second millennium AD is partly balanced by the amount of material coming from surface collections (Sand and Ouetcho 1992a), though the precise antiquity of these collections of non-ceramic artefacts is necessarily poorly defined. The last bias concerns the lack of detailed publications from most of the archaeological sites surveyed and excavated in New Caledonia before 1991, leading to an almost impossible task of listing all the non-ceramic material discovered. Although I have tried to go through almost all the published reports and publications in my files, most of this paper has to rely on the work carried out by our local Department of Archaeology in Nouméa.[1]

The general ceramic chronology for New Caledonia and changes in exchange cycles

The scope of the paper does not include a detailed presentation of the ceramic chronology from the archipelago, which is given elsewhere (Galipaud 1988a; Sand 1995a, 1996b). But the local prehistoric chronology will probably always be based on this artefact class, and it appears that the best way to identify changes in non-ceramic materials is to place them in the well-structured ceramic sequence (Fig. 2).

The first settlement of New Caledonia, as part of the spread of Austronesian groups into Remote Oceania, is related to the local development of the Lapita Cultural Complex. Our recent studies on this phenomenon (Sand 2000a) have shortened the period of Lapita pottery production to about 300 years, between around 1050–1000 BC and 800–750 BC. It is the non-dentate stamped pots of the ceramic complex that continue after the demise of the intricate motifs and complex vessel forms, with paddle-impressed Podtanean ceramics, and incised as well as non-decorated pots. Local evolutions within the archipelago, especially between the north and the south of the Grande Terre, have led to the identification, during the second half of the first millennium BC, of a tradition of incised ware, named Puen, restricted to the south (Sand 1999b). This first millennium of settlement has been termed the "Koné period".

At the end of the Koné period, it appears that cultural differences between the north and the south were already clearly marked, probably associated with the first divergence of language. In the south, the Puen tradition gives way at the beginning of the first millennium AD to thicker pots with horizontal handles, of the Plum tradition (Sand 1995a). These pots mark the start of the recent ceramic period, called the "Naïa period" for the south and the "Oundjo period" for the north. The complexity of the ceramic evolutions in the northern part of the Grande Terre is as yet unclear, but by about 1000 AD a final change in the ceramics takes place, with predominantly thick globular Oundjo-tradition pots,

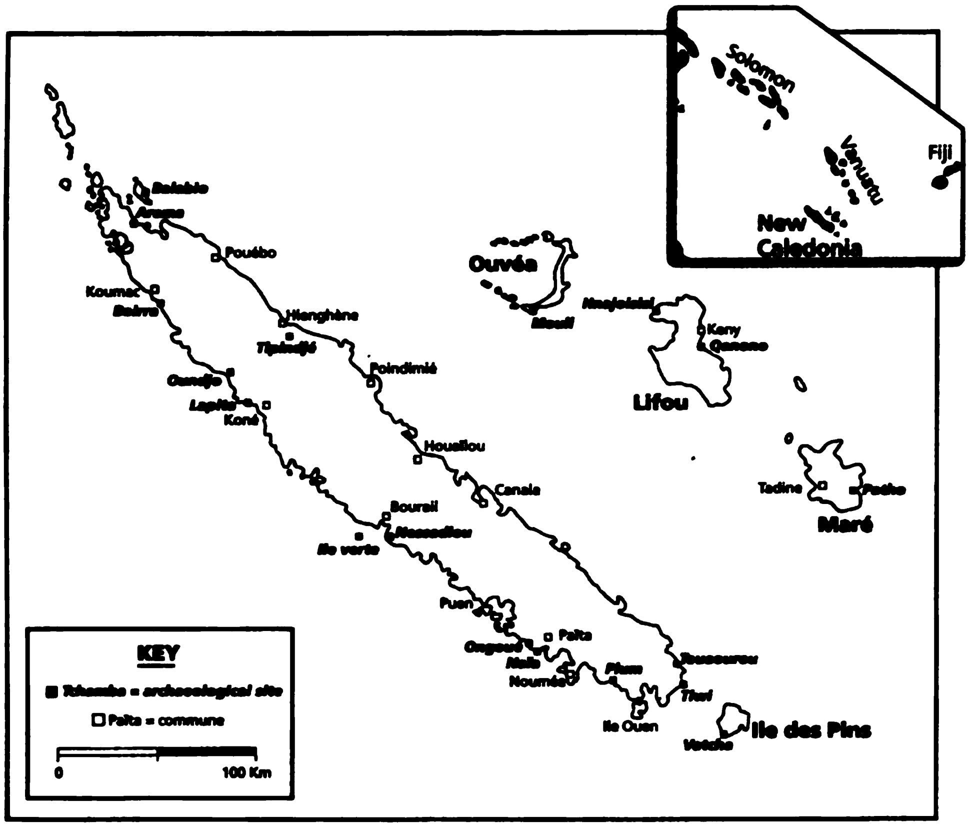

Fig. 1. Map of New Caledonia with the position of the major sites discussed in the text.

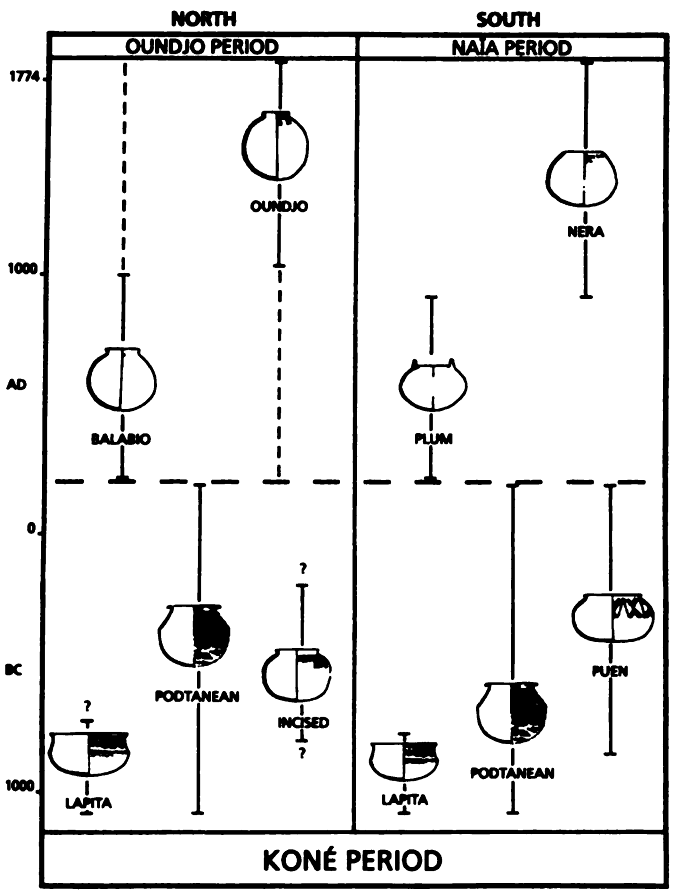

Fig. 2. The general ceramic sequence of New Caledonia.

sometimes incised, in the north (Sand 1996c), and thin nubbin and incised decorated Néra pots in the south (Sand 1994b, 1995a).

This complex sequence is paralleled in the evolutions and redefinition of the exchange networks, especially between the Grande Terre and the Loyalty Islands, with important consequences for the spread of the artefacts between the different parts of the archipelago. During the Koné period and the very beginning of the Naïa–Oundjo period, the relations of the Loyalty Islands seem to have been mostly turned towards the northern part of the Grande Terre (Sand 1995b). During the first millennium AD relations seem to have been very limited, before a new development at the beginning of the second millennium AD, with Maré and Lifou more related to the south of Grande Terre and Ouvéa having a mixed material of northern and southern origin (Carson 2000; Sand 1998b; Sand et al. 1998).

The non-pottery component of the prehistoric sequence in New Caledonia

The listing of the different non-ceramic artefacts found in archaeological sites of the Grande Terre and in the Loyalty Islands has led to the creation of 10 different artefact categories, taking into account the great majority of items found.[2] In this paper, I have grouped together (a) stone adzes and axes, (b) stone-flake tools, (c) other stone artefacts, (d) stone ornaments, (e) shell tools, (f) shell rings, (g) other shell ornaments, (h) bone material, (i) fishing gear and (j) clay objects.

Stone adzes and axes

All those knowing the ethnographic material from New Caledonia will have come across a particular type of flat serpentine or semi-nephrite triangular-shaped Kanak adze and axe found in museums worldwide (Orliac 1990). Fewer might know that there is a real chronological evolution of the polished adzes in the archipelago during the prehistoric chronology.

During the Lapita period, at first settlement, the adze typology is varied: flat-faced medium-sized adzes with a lenticular cross-section and flat sides (Fig. 3a), long oval-section adzes with narrow flat sides (plano-lateral) (Fig. 3b), small flat adzes not exceeding 5 mm thickness (Sand 1996a:Fig. 46, 2000:Fig. 7). Most of these polished adzes are made in a dark green rock, a type of material apparently used only during Lapita times. In some instances, we have an indication that the adzes were worked or reworked on site.

Only the long oval-section adzes were made during the rest of the Koné period, and these often have rounded elliptical sections. The raw material also changed with the use of a greyish siliceous phtanite (Fig. 3c). These late Koné period adzes are heavier and longer than the Lapita adzes, sometimes tripling the maximum width, with an average length of 22 cm. They are found in sites associated with paddle-impressed Podtanean pots as well as in sites associated with incised Puen pots in the south of the Grande Terre (Galipaud 1988a:Fig. 89; Sand and Ouetcho 1992a:Fig. 61a-c; Sand 1996b:Fig. 11).

A profound change in adze forms occurred during the first millennium AD. In the first part of the millennium, it appears, from data collected in the south of the archipelago, that long adzes were still the major component. But axes of trapezoid or triangular shape with a biconvex section, made out of light green rocks of serpentine or semi-nephrite, are also associated with handled pots of the Plum tradition. The few examples from the first millennium AD are of small size (Sand 1994b:Fig. 98a) (Fig. 3d), but evolve during the second millennium AD to give the numerous triangular-shaped, biconvex or lenticular section adzes and axes (Gifford and Shutler 1956:Figs. 1–3) (Fig. 3e). These have been found in some excavations (Carson 2000; Sand et al. 1998:Fig. 15) but mostly come from surface collections from late prehistoric sites (Galipaud 1988b:Figs. 8–9; Sand and Ouetcho 1993a:Figs. 6, 13). To date, we have not been able to identify in the excavated sites any sign of *in situ* adze manufacture, leading us to think that most late-period adzes and axes were produced in special places, probably close to the stone source.

Finally, one of the unique polished items characteristic of New Caledonia, the 'hache ostensoir' axe, composed of a flat rounded or ovoid jade (nephrite) disc hafted to a wood handle by two holes, is restricted to the second millennium AD (Sand 1995a:155–158) (Fig. 4a). This ceremonial axe was exchanged through particular trade circles between the Grande Terre and the Loyalty Islands (Kasarhérou 1990; Leenhardt 1937:95–96).

Stone-flake tools

Until the last decade, work on the stone-flaked tool material from the Grande Terre had been minimal (Cayrol 1982). A set of studies conducted by H. Forestier (1996, 1999), trained in French Paleolithic flaking, has recently helped to better understand the diversity of this type of artefact. The first point about the stone-flaked tool assemblages found in archaeological contexts is the variety of the geological materials used. Although phtanite is the most usual type of easily accessible rock suitable for flaking, once correctly prepared, the excavations have shown the use of jasper, chert, quartz, rock crystal and a form of basalt, not to mention some rare obsidian flakes (Sand and Sheppard 2000). All these rocks have different natural structures and were not flaked in the same way.

What appears to be the major characteristic from the beginning of the chronology is the diversity in the size of the stone-flake tools which is related to the distance from the stone source. In the Lapita sites of the Grande Terre, flaked tools are numerous and often large (Forestier 1999) (Fig. 4b). Forestier's study has shown that the major form produced was a discoid flake, indicating the advantage resulting from a technique suited for the type of stone material present in New Caledonia (1996). Flakes as well as cores are present in the sites (Sand 1996a:Fig. 44) (Fig. 4c). In the Lapita sites in the Isle of Pines and the Loyalty Islands, where raw material was more difficult to get or was absent, the stone flakes are less numerous and are also much smaller in size, with the presence of a micro-tool series, with fine points (Sand 1996a:Fig. 82), probably used to drill shell beads (Fig. 4d).

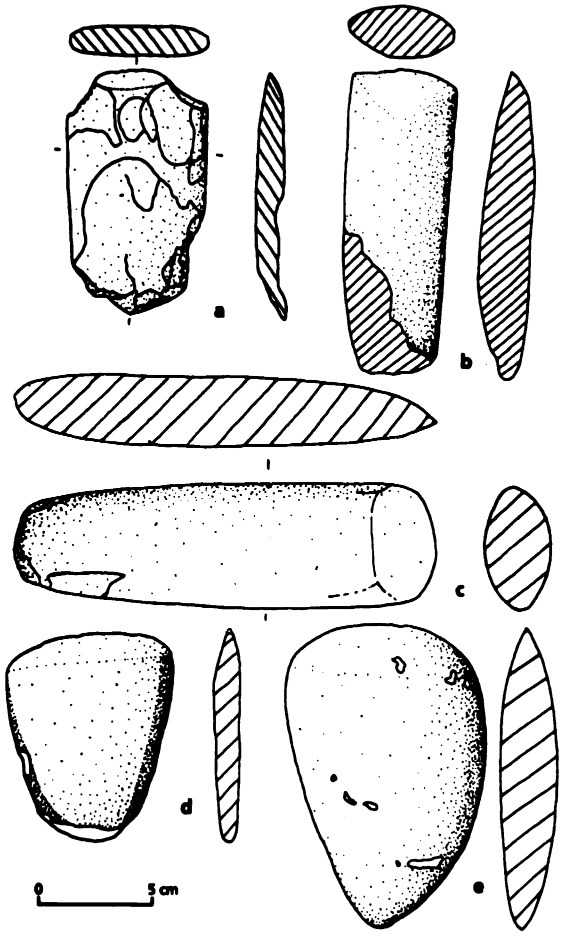

Fig. 3. Chronological transformation of stone adzes and axes.

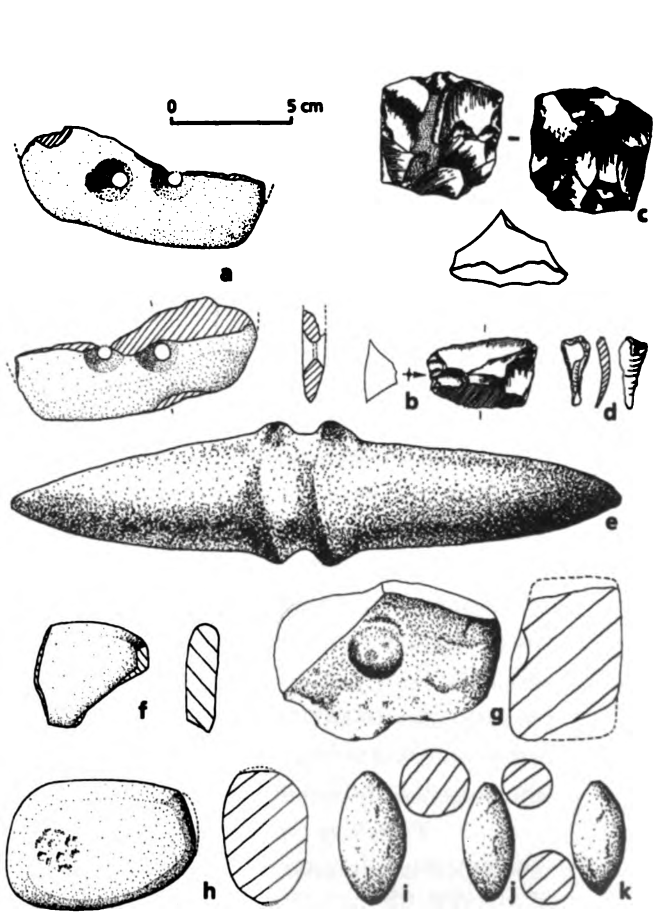

Fig. 4. Ceremonial axes and stone tools.

Forestier (1996) has not seen sharp differences between the stone-flaked tool industry of the Koné period and of the later Naïa period in the Naïa sites excavated by C. Smart in the 1960s. The only absence we have observed in late sites is the fine points. Our experience in excavating sites from the Naïa–Oundjo period suggests a regional diversification of production, with the presence of a few specialised sites containing large amounts of stone-flaked tools. The most complete study conducted to date has centred on the unclearly dated rock shelter NKM004 in the Koumac valley (northwest coast) (Sémah et al. 1995), where Forestier has identified large and thick pieces of pseudo-Levalois type, with unique artefacts like a horse hoof, of a technological type similar to that found in Pleistocene sites of Australia (Forestier 1994:Fig. 33). Excavations conducted in comparable environments on rock shelters of the northeast coast have netted, in contrast, very few stone flakes (Sand et al. 2000), pointing again to the special nature of the Koumac valley site.

In conclusion, it appears that the differences observed in the stone-flaked tool material have more to do with the local geology and the type of site than with technical changes, and that the major production technology was the discoid method from plano-pyramidal, bipyramidal or polyhedric cores (Forestier 1996).

Stone ornaments

Stone ornaments are relatively rare in archaeological contexts. The meticulous sieving of archaeological sediments has recently multiplied the number of objects in this category.

Flat ornament: The only relatively large stone object that is classified as an ornament was found in a late prehistoric context in a rock shelter on Ouvea (Carson 2000; Sand et al. 1998:Fig. 39) (Fig. 5d). It consists of a polished flat rock (possibly the waist of an axe), with two drilled holes through the flat sides. The rock is not a type of semi-nephrite, but this ornament looks very much like the pendants present in Tanna (southern Vanuatu) made from waisted adzes from New Caledonia.

Rock beads: The only regular type of stone ornament observed by the first Europeans was a type of necklace made from small, flat or rounded beads of serpentine or semi-nephrite (Glaumont 1888). Beads of this type have only been found archaeologically in contexts of the second millennium AD. Specimens of different sizes and thickness are present on the west and east coast of the Grande Terre (Gifford and Shutler 1956:Plate 10; Sand et al. 2000:Fig. 26), as well as in the Loyalty Islands, where they were traded (Sand and Ouetcho 1993c:Fig. 35; Sand 1995b:78) (Fig. 5e–f). The only longer specimen published (33 mm) comes from a burial and was probably worn on its own (Gifford and Shutler 1956:Fig. 3c). A small perfectly polished ring made out of semi-nephrite has been found in a rock shelter on the northeast coast (Sand et al. 2000:Fig. 27) (Fig. 5g). Two parts of a small cylinder made out of soft steatite — one with a lateral hole — have been found in Oundjo period sites of the northern part of the Grande Terre (Sand 1996a:Fig. 154, 1997b:Fig. 15) (Fig. 5h), where this type of rock is present.

Other stone artefacts

Excavations and surface collections during surveys have recovered a large amount of stone items not classifiable in the two preceding categories. An initial division of these items is presented here.

Picks: A particular type of polished stone, still used in some areas as "magic stones" in the 19th century (Lambert 1900), seems, from field data indicating the discovery of some picks in early sites, to be related to Koné-period contexts, although none of these objects has to date been found in excavations. These are the double-pointed picks with a central groove, made in an unspecified dark rock (Boulay 1990) (Fig. 4e). The work needed to produce these fine and complicated objects, as well as other polished forms today housed in private collections (Frimigacci 1975:Plate 2i, l), is an indication of the presence of specialists and of a probable symbolic use of these unique objects.

Polishing stones: These are made from different types of rock depending on the local geological environment. The diversity in size and hardness is best represented in Lapita sites, which have small abraders in soft and hard rock (Fig. 4f) and long narrow stone 'sticks', probably used for smoothing shell rings (Sand 1996e:Fig. 34). In later sites, the emphasis seems to be on larger abraders (Sand 1997b:Fig. 15).

Pebbles with cupules: A series of round or flat pebbles with one or two cavities in their centres are found in Lapita sites. These objects have been interpreted as nut-crackers (Frimigacci 1975: Plate 51; Sand 1996a:Fig. 45). Few objects of this type have been found in late sites (Sand and Ouetcho 1992a: Fig. 62) (Fig. 4g), pointing to a change in the use of tree crops, although the use of nuts in the diet is recorded in the ethnographic period (Sand 1999a). Also associated with Lapita sites are soft rocks with deep cupules, of unknown function (Sand 1996e:Fig. 37). A different type of cupule stone, clearly used for grinding small rounded shell beads, has been found in an early Lapita context on the Grande Terre (Sand 1996e:Fig. 37) as well as in a late context in the Loyalty Islands (Carson 2000; Sand et al. 1998:Fig. 44).

Stone hammers: Pebbles with impacted edges, of different size and shape (Fig. 4h), are present from the beginning of the prehistoric chronology (Carson 2000; Gifford and Shutler 1956:Plate 11; Sand and Ouetcho 1993c:Fig. 30; Sand 1996a:Fig. 45; 1996e:Fig. 33; Sand et al. 1998:Figs. 41–42). To date no real study has been conducted on these artefacts, and their degree of temporal variability is unknown.

Sling-stones: Slings were used by the Kanaks for bird-hunting and in warfare (Leenhardt 1937). Special sling-stones were produced for this purpose. They were made out of small elongated river pebbles, polished at both ends (Fig. 4i–k) in order to have good aerodynamics and a sharp destructive effect. These sling-stones are restricted to the late part of the prehistoric sequence (Gifford and Shutler 1956:Plate 10; Sand 1994b:Fig. 17; Sand et al. 1999b).

Net sinkers: To date, no definitive net sinkers in stone have been identified at Koné-period sites. The Naïa–Oundjo period has on the contrary produced evidence for the use of sinkers made in different rock types. The characteristic type on the Grande Terre is a flat rock, roughly flaked, with a large ground or drilled hole in one extremity or in the centre (Sand 1994b:Fig. 8). Most of these items are found on seashore sites and have a rounded or rectangular shape (Sand 1994b:Fig. 130) (Fig. 5a), the examples found in river valleys being of a more narrow form (Sand 1997b:Fig. 15) (Fig. 5b). One example of a thick pierced and rounded sinker has been illustrated by Gifford and Shutler (1956: Plate 10). A series of flat river pebbles with their sides flaked, probably to fix a string, has been found in rock shelters on the northeast coast (Sand et al. 2000:Fig. 24) (Fig. 5c) and in Ouvea (Carson 2000; Sand et al. 1998:Fig. 46). Finally, in the Loyalty Islands, the late period saw the production of heavy oval sinkers with a central groove, made from locally available stalactite fragments (Sand 1995b:Fig. 13).

Shell tools

Until the last decade, it was common to say that New Caledonia had not witnessed any real form of shell-tool technology in contrast to the richness of the stone-tool assemblages. Recent survey and excavation have altered this conclusion, although it remains evident that the archipelago is not as rich in shell tools compared, for example, with neighbouring Vanuatu (Garanger 1972).

Tridacna shell adzes: Clam-shell adzes are rare in archaeological contexts. One example of an unfinished rectangular thick adze, made from the heavy hinge portion of the shell, has been found in a Lapita context (Sand 1996e:Fig. 38). Three other adzes of various sizes have been found in the southeastern part of the Grande Terre, near sites occupied from the Koné period on (Galipaud 1988b: Fig. 10; Sand and Ouetcho 1992:Fig. 64) (Fig. 6a). It appears that this type of tool was restricted to the early part of the sequence, like the *Tridacna* ornaments (see below). The only possible exception is found on the small isolated raised coral island of Walpole, where the limited geological environment might have fostered the production of large, heavy tools made in fossil *Tridacna* shells (Sand 1995c:Fig. 15, 19) (Fig. 6b).

Conus shell adzes: One possible *Conus* shell blade has been identified in the material from the Lapita site of St Maurice-Vatcha on the Isle of Pines (Sand 1996d) and two from the Koné period site of Oungoué (Sand 1995a:Fig. 64) (Fig. 6c). Only one definite *Conus* adze has been found in the Loyalty Islands, in a site dated to the late period (Sand 1992b, 1995a:Fig. 124).

Terebra gouges: *Terebra maculata* shells, with their apex polished or sharpened, were probably used as gouges. These tools have been found in different sites on the Grande Terre (Galipaud 1988b:Fig. 7f; Sand and Ouetcho 1992a:Fig. 63), as well as in the Loyalty Islands (Bolé et al. 1994:Fig. 8, 18) (Fig. 6d). In all cases, they seem to belong to a late context. The most interesting thing is that the *Terebra* are polished on the

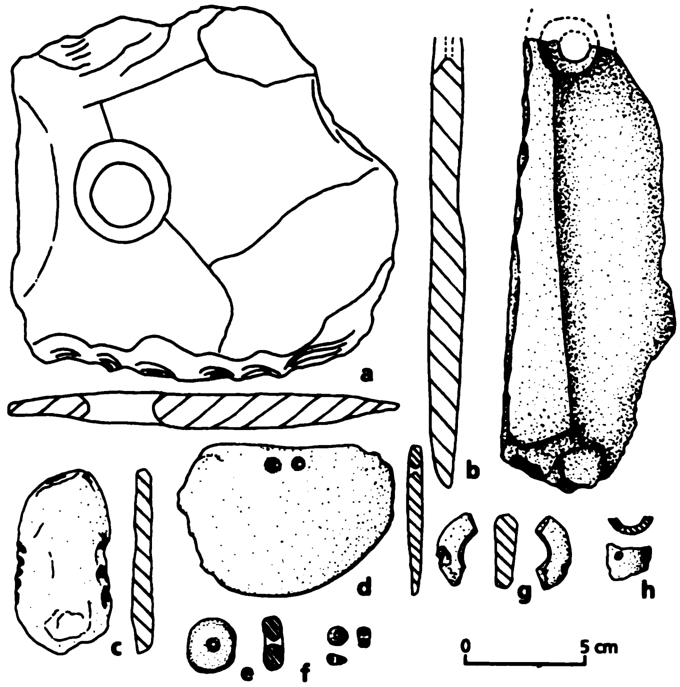

Fig. 5. Stone net sinkers and ornaments.

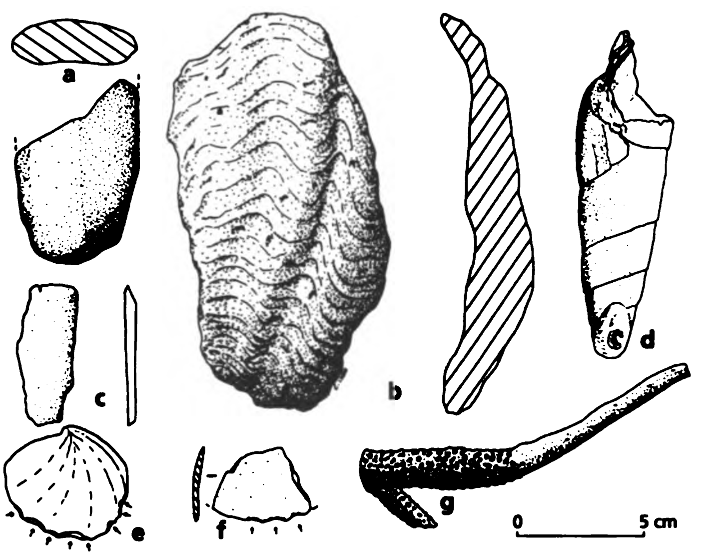

Fig. 6. Shell tools and coral abrader.

distal edge, as in Fiji–West Polynesia (Best 1984:Fig. 6.27; Poulsen 1987:Plate 67), and not on their proximal section, as in the rest of Melanesia and especially in neighbouring Vanuatu (Garanger 1972:293).

Shell scrapers: Different types of bivalves are still used today as scrapers, especially for the peeling of tubers. The identification of purposeful flake marks on the edge of bivalves (Fig. 6e) is most of the time controversial, as these can be caused by several factors (Gifford and Shutler 1956:Plate 7d; Galipaud 1988a:Fig. 65; Sand 1998b:Fig. 8p–q). For the sake of precision, these will not be discussed further here. The only bivalves bearing clear signs of use are some polished oyster shells that are mostly, but not entirely, fish-hook production waste only (Fig. 6f). One of these shells, found in an early Naïa period site, has clear signs of indentation in three places (Galipaud 1988a:Fig. 88). Another complete oyster shell, completely polished, has been found in a late context in a rock shelter on Ouvea (Sand et al. 1998:Fig. 39). Associated with it was the only definite example of a coral polisher (Sand 1995b:78) (Fig. 6g).

Shell net sinkers: As for the bivalve shell scrapers, it is difficult to separate the bivalves bearing purposeful holes for attachment to a net from those simply broken by other means. Pierced bivalves occur in most of the sites (Gifford and Shutler 1956:Plate 7g–h), but their frequency has not been evaluated.

Other used shells: Worked pieces of *Lambis lambis* are reported for the site of Boirra on the west coast (Frimigacci 1981), but their use remains unclear (Sand 1995a:101).

Shell rings

Without question, the bulk of the manufactured shell artefacts found in archaeological sites are the remains of shell rings. As has already been noted by other prehistorians, the term 'ring' is more accurate than 'armband', as some of the shell diameters are too narrow to allow use on the arm (Kirch 1988:110). I have divided the types by marine shell species, in order to identify possible evolutions.

***Conus* shell rings:** *Conus* rings are the most numerous remains found. Rings of various diameters are present in sites throughout the sequence. Complete specimens as well as broken pieces and remains from the production process occur in archaeological contexts on the Grande Terre (Gifford and Shutler 1956:Plate 6; Frimigacci 1975:Plate 50; Sand 1996e:Figs. 40–44) and in the Loyalty Islands (Sand 1998b:Figs. 5, 6, 8; Sand et al. 1998:Fig. 38). Typologically, the *Conus* shell rings can be divided into two schematic types: specimens with narrow sides and specimens with large sides (Fig. 7a), although intermediate forms exist. Some of the larger incomplete specimens bear drilled holes on their sides (Galipaud and Kasarhérou 1986:Fig. 6; Gifford and Shutler 1956:Plate 8e; Sand 1996a:Fig. 63, 1998c:Fig. 9) (Fig. 7b), possibly for the attachment of different plates or for a string, as is known for ethnographic objects. Some of these objects can be classified as 'rectangular units', but this is not always the case. No distinctive chronological differences have been noticed in relation to size. The only significant characteristic lies in the types of decoration made on the rings (Sand 2000a:Fig. 8). During the Lapita sequence, some medium-to-large specimens were decorated by one to four parallel incisions on the outer surface (Sand 1999c:Fig. 12) (Fig. 7c). Others were incised or needle-pointed to make geometric motifs (Frimigacci 1982:Fig. 17; Sand 1996a:Fig. 47) (Fig. 7d–e). Apparently, this type of surface decoration disappeared at the end of the Lapita period and only plain rings were made from that time on.

***Trochus* shell rings:** As for the *Conus* rings, no evident differences can be identified in the remains of *Trochus* rings and their production waste is found throughout the sequence (Fig. 7f–g). Their size and method of manufacture also appear similar through the sequence (Gifford and Shutler 1956:Plate 8r–t; Sand and Ouetcho 1992a:Fig. 65a, b; Sand 1996a:Fig. 47). This might simply be due to the narrow range of technological possibilities offered by this shell. The only exceptions are some specimens found in a late chronological context in rock shelters from Ouvea (Carson 2000; Sand et al. 1998:Fig. 26) (Fig. 7h–i) and from the northeast coast (Sand et al. 2000:Fig. 24), which are decorated with different types of regular transverse incision forming a zigzag pattern (for a regional comparison see Newman 1975).

***Tridacna* shell rings:** Contrary to the two preceding types of shell ring, *Tridacna* shell appears clearly linked to the Koné period (Sand 2000a). This hard shell, large and difficult to work, is present in the form of finely polished discs and bands of different shape and thickness (Galipaud 1988a:Fig. 25; Sand 1996a:Figs. 63, 86, 106; Sand 2000a:Fig. 8; Sand and Ouetcho 1992a:Fig. 65c) (Fig. 7j–k). Some are very thick, made from the heavy hinge portion of the shell, and others are thin, with only a narrow hole in the middle (Sand 1994b:Fig. 99; Sand 1996c:Fig. 9; Sand and Ouetcho 1992a:Fig. 86) (Fig. 7l).

Other shell ornaments

Other Tridacna ornaments: Some long units with a hole at each end, shorter than those known in the Eastern Lapita complex (Poulsen 1987:Plate 70; 1–7), are present in some Lapita sites (Sand 1996c:Fig. 9, 1999c:Fig. 12) (Fig. 7m). Apart from a single worked *Tridacna* shell fragment found in a rock shelter on Ouvea (Carson 2000; Sand et al. 1998:Fig. 38), no evidence for the production of clam-shell ornaments has been found in Naïa-Oundjo sites. This parallels the situation known at present for the *Tridacna* adzes and seems to confirm that the use of this shell was limited to the Koné period, predominantly in the Lapita part.

Shell beads: Shell beads of different sizes, made out of bivalve and gastropod shells, have been found during the last decade in most of the sites excavated (Fig. 7n). Their production started in Lapita times (Sand 1999c:Fig. 12) and continued to European arrival (Sand et al. 2000:Figs. 24–25). No real differences have been noticed between the periods, with manufacture of mostly flat beads, probably used for necklaces and/or traditional money. The evolution may, though, lie in the final use of the beads and not in their production. Small perforated rectangular beads, mostly made out of a type of *Spondylus* shell, are at present restricted to Koné period sites (Sand 1999c:Fig. 12) (Fig. 7o). These ornaments complete the picture of a distinctive shell assemblage set in the early part of the New Caledonian chronology. To be noted is the presence of beads made from cut pieces of echinoid spines in rock shelters from the northeast coast (Sand et al. 2000:Fig. 24).

Oyster shell ornaments: Worked oyster-shell fragments are present in most archaeological sites in the archipelago, probably as fish-hook manufacture waste, but the existence of distinct ornaments made from this shell is restricted at present to the Naïa-Oundjo period. Very diversified ornaments are present in sites, often a single unique item. Some ornaments are very small, like the carved objects less than 1 cm long and only a few millimetres wide found in rock shelters on Ouvea (Carson 2000; Sand et al. 1998) (Fig. 7p). A fine pendant with a distinct hole has been found in Nessadiou (Sand 1996a:Fig. 130) (Fig. 7q). Different forms of small flat plates or grooved pendants with a hole are also known from Ouvea (Carson 2000; Sand 1998b:Fig. 8g,h; Sand et al. 1998:Figs. 20, 39) (Fig. 7r), Tiouandé (Sand et al. 2000:Fig. 25) and Tiwi (Galipaud 1988b:Fig. 7d–e). A broken long unit with a rounded end, pierced by four holes of different sizes from Ouvea (Sand et al. 1998:Fig. 8) (Fig. 7s), is similar to elements used in the production of the large Solomon Island shell-money beads. Other oyster-shell artefacts are rounded discs (Carson 2000; Sand et al. 1998:Fig. 38). Some may have been used on wooden sculptures, others have been incised on the lip and might be personal ornaments.

Miscellaneous objects: Flat rounded 'shell discs' made from the upper portion of the *Conus* shell, pierced in the centre, stand out as being present only in Lapita sites (Sand 1998c:Fig. 9) (Fig. 7t), although this could be an artefact of the smaller samples from the rest of the sequence. A unique small long shell object found in Hnajoisisi rock shelter on Lifou, with two very small holes, might have been used as traditional money (Sand et al. 1999a:Fig. 8) (Fig. 7u). The discovery of gastropod shells used as ornaments and probably dance items in a burial on Ouvea (Carson 2000; Sand et al. 1998:Figs. 18, 38) indicates multiple uses for shell ornaments. Some with holes (Galipaud 1988a:Fig. 88b), or that have been polished (Sand 1998b:Fig. 8o; Sand et al. 1998:Fig. 8) fall in this category.

Bone material

Artefacts made from fish or bird bones are rare in sites. The under-representation of bone objects in the Koné-period sites may be due to conservation problems. If so, our sample would therefore be incomplete and comparison between the two major chronological periods difficult.

Three worked bones have been found in layers dated to the first millennium BC. In the Lapita site of Vatcha, a fish vertebra has been polished and pierced (Fig. 8a), probably to be put on a string (Sand 1999c:Fig. 12). In the lowest layers of a rock shelter from Tiouandé on the northeast coast (Sand et al. 2000:Fig. 26) and Hnajoisisi in Lifou (Sand et al. 1999a:Fig. 8) two small needles with a hole have been found (Fig. 8b–c).

More bone material has been found in archaeological sites dated to the Naïa-Oundjo period, especially to the late part of the period. Different types and lengths of needles have been excavated in rock shelters from the southeast coast (Galipaud 1988b:Fig. 6a) and Ouvea (Carson 2000; Sand 1998b:Fig. 8r; Sand et al. 1998:Fig. 38). Two large polished bones, probably from a mammal, one of which has a hole at one end, have been found in the same sites (Carson 2000; Galipaud 1988b:Fig. 6b; Sand et al. 1998:Fig. 40) and might have been used as daggers or as tools for house construction. To be noted are the numerous worked bone points and needles found in a currently undated context on the island of Walpole (Sand In press b).

The only miscellaneous bone artefact listed is a cut piece with a narrow side and a hole in its centre (Carson 2000; Sand et al. 1998:Fig. 15); it may be part of an earring.

Fishing gear

An unexpected quantity and variety of fishing gear has been found in recent excavations. They show marked evolutions in typological forms for the hooks, the most numerous objects found.

Fish hooks: Ten years ago only two fish hooks were known from archaeological contexts in New Caledonia (Frimigacci 1982:13). We have now increased the sample to 36 hooks, plus numerous fragments and examples of production waste. Examples are present for all periods, allowing the identification of this artefact's typological evolution. The main change observed is the existence of a distinctive Lapita fish hook, characterised by a type of long hook with a grooved attachment (Sand 1996a:Fig. 48) (Fig. 8d), comparable to what has been found in other Lapita sites in northern Melanesia. The second Lapita hook type is much finer, but with a more angled point (Fig. 8e). For the Grande Terre, the rest of the chronology is illustrated at present by four hooks. One very small example from the

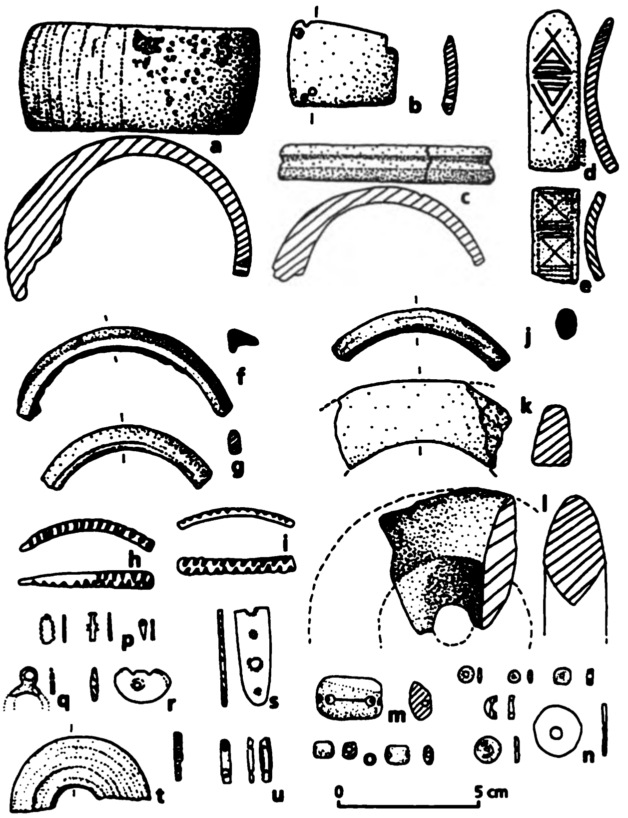

Fig. 7. Shell ornaments.

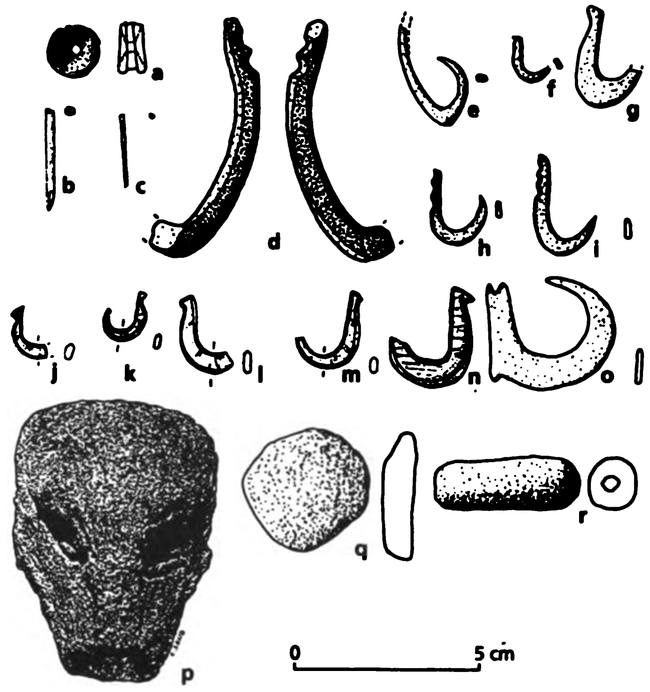

Fig. 8. Bone material, fish hooks and clay objects.

middle part of the Koné period on the east coast (Sand et al. 2000:Fig. 24) (Fig. 8f), one thick example from the late part of the Koné period on the west coast (Sand et al. 1999b) (Fig. 8g), and two undated specimens from near Nouméa (Baret et al. 2000) (Fig. 8h–i).

The situation is very different in the Loyalty Islands, where most of the New Caledonia hooks come from rock shelters (Carson 2000; Sand 1998b:Fig. 2i, 6f–i; Sand et al. 1998:Figs. 8, 9, 11, 12, 24, 38, 40; 1999a:Fig. 9). No Lapita-related hooks have been found to date, and the difference in typology seems at present to overlap the two chronological periods. These differences are in the size of the hooks and not in any kind of apparent stylistic evolution. We get large, medium-sized and small hooks, with two distinctive miscellaneous hooks from Ouvea (Fig. 8j–o).

Composite hooks with lures: Some fragments of what seem to be part of composite hooks are present in some sites (Carson 2000; Sand 1996a:Fig. 81; Sand et al. 1998:Fig. 40; Sand et al. 2000:Fig. 25). However, no clear examples of hook points with attachments have been identified.

Octopus lure: Cut upper parts of the *Cypraea* shell have been used for octopus lures (Gifford and Shutler 1956:Plate 7j; Sand 1996a:Figs. 72, 81; Sand 1996e:Fig. 46), a technique clearly present in New Caledonia since first Austronesian settlement.

Clay objects

Surprisingly, in an archipelago so rich in pottery production and where clay is so abundant on the large island, few clay objects have been found in prehistoric sites to my knowledge, putting aside one modelled Lapita clay head (Frimigacci 1981; Sand 1996a:Fig. 162) (Fig. 8p). To date, only two types of distinctive artefacts can be listed and both are found in Lapita contexts. The first is a set of clay discs with their sides polished, possibly used as gaming pieces (Frimigacci 1975:Plate 48a; Sand 1996e:Fig. 27) (Fig. 8q). The second is a small cylinder with a hole in its widest end (Sand 1996e:Fig. 49) (Fig. 8r) that might have been used as part of a necklace or as another type of ornament.

Analysis

Chronological changes in non-ceramic artefacts

The listing of the different types of non-ceramic artefacts found in archaeological sites of New Caledonia has shown that a very diversified set of objects is present. In the course of this paper, I have tried to highlight the geographical as well as the chronological variation present. As a general synthesis, a classification of the data has been conducted in a seriation table without following the artefact order given in the paper, to help identify the possible chronological significance of different kinds of item. The result, although partly incomplete because of biasing agents discussed in the introduction, nevertheless shows a clear pattern of evolution (Fig. 9). Three aspects are highlighted in Fig. 9. First, a restricted range of Lapita-related objects. Second, a set of objects crossing nearly the whole prehistoric chronology; and third, a specific late period with many new items.

The Lapita period, restricted to about 300 years, marks the first settlement of New Caledonia. The items present in sites are, though, not of local invention, but are part of a cultural kit originating from outside the archipelago (Green 1992, 1995; Kirch 1997). The specific types of adzes, fish hooks, decorated rings, special shell ornaments, as well as the distinctive Lapita pottery, are unquestionably related to the widespread 'Lapita Cultural Complex'. The most revealing conclusion of the regional comparison is the clear similarity of non-ceramic items throughout island Melanesia during the Austronesian spread: most of the objects found in the Lapita sites of New Caledonia are very like those found in the Bismarcks, Solomons and Vanuatu (Kirch 1988, 1997; Spriggs 1997).

As for the dentate-stamped pots, the demise of specific types of Lapita objects before the middle of the first millennium BC must be seen as a profound evolution in the local society. It is not only the intricately decorated pots that drop out of the cultural set after the first centuries of settlement, but a wide part of the coloniser's ancestral culture. This shift in the production of specific items may be related to a shift in cultural symbols, related to the slow process of establishing the different Austronesian groups in their 'new' land. Diversification of settlement pattern, the spread inland, population growth, general abandonment of first settlement sites and relocation nearby, all point to a phase of rapid cultural evolution. Complex relationships necessitated during the discovery/settlement phase (Graves et al. 1990; Kirch 1997; Sand 1996a) had lost part of their meaning (Sand 1996a) and new social functionings were creating a new and more localised cultural context (Sand 1999b). It is, I believe, the breakdown of the early Lapita-type relationships that led to the disappearance of the multiple specialised dentate-stamped pots and non-ceramic items, leading to the development of more simple productions over time: simple forms of fish hooks, and ornaments, mostly utilitarian ceramic vessels, stone adze forms and flake tools adapted to the local rock types. The second part of the first millennium BC was also characterised by regional diversification within the archipelago, with an interaction sphere linking the northern part of the Grande Terre with the Loyalty Islands (Sand 1998b), and a different cultural development in the southern part of the Grande Terre (Sand 1999b).

The 1500 years of the post-Lapita chronology seem to be characterised by slow changes in material culture. The major difficulty is to identify whether this seemingly slow process is the result of a historical reality, or if it is due to the under-representation of archaeological studies on this period. In about 1500 years, we see mainly progressive but profound changes in adze/axe forms and in the rock types used, and the development of new types of fish hooks, in parallel with the appearance and geographical diversification of regional pottery traditions (Sand 1996a). The beginning of the first millennium AD is marked by the development of the handled Plum pottery tradition, whose forms are unique to New Caledonia. Culturally, we can consider from that time on that we have in the archipelago mainly 'local indigenous' cultural traits, that have arisen during the Koné period from the first Austronesian settlers (Sand 1999b). The first millennium AD also sees the visible shortening of relationships between the Grande Terre and the Loyalty Islands (Sand 1998b), probably linked, in part, to some form of population pressure and political centralisation of power in different chiefdoms (Sand

	KONE PERIOD							NAIA/OUNDJO PERIOD							
	LAPITA			PUEN				PLUM				NERA/OUNDJO			
BC/AD	1000	800	600	400	200	0	200	400	600	800	1000	1200	1400	1600	1800
Lapita adzes/axes 3a	■	■													
Stone drill points 4d	■	■													
Decorated armbands 7d,e	■	■													
Nut crackers 4g	■	■	■			?									
Early hook forms 8d,e	■	■		■	■	■									
Pottery objects 8p,q,r	■	■													
Tridacna ornaments 7j,k,l	■	■	?												
Long adzes 3b	■	■	■	?	?										
Tridacna tools 6a	■	■	■	?											
Long picks 4e	?	?	?												
Long lenticular adzes 3c			■	■	■	■	■	■	?						
Discoid flakes 4c	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Polishing stones 4f	■	■	■	■	■	?	■	■	?	■	■	■	■	■	■
Conus armbands 7a,b,c	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Trochus armbands 7f,g	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Shell beads 7n	■	■	■	?	■	■	?	■	?	?	■	■	■	■	■
Loyalty Island hooks 8j,k,l,m,n,o			■	?	■	?	■	■	■	■	■	■	■	■	■
Small triangular adzes 3d									■	■	■	■	■	■	■
Large triangular adzes/axes 3e										■	■	■	■	■	■
'Hache ostensoir' axe 4a											■	■	■	■	■
Sling stones 4i,j,k									■	?	■	■	■	■	■
Net sinkers 5a,b									■	?	■	?	■	■	■
Stone ornaments 5e,f,g,h											■	■	■	■	■
Terebra gouges 5d										?	■	?	■	■	?
Oyster shell ornaments 7p,q,r											■	■	■	?	■
Oundjo incised armbands 7h,i											■	?	■	?	?

Fig. 9. Seriation table of the non-ceramic artefacts from New Caledonia.

1996f). But once again, our knowledge of this millennium is restricted to a few sites, and the possible complexities in local cultural development are at present difficult to identify.

Things change markedly around the turn of the second millennium AD. In the seriation (Fig. 9) distinctive new items, from ornaments to ceremonial axes and tools, appear. These objects develop in a precise time frame, in conjunction with the general intensification in the use of the Grande Terre landscape for horticultural purposes (Sand 1995a, 1996a, 1999a; Sand et al. 2000), the appearance of new types of pots (Sand 1996c, 1999d) and the multiplication of organised relationships between the main island and the Loyalty Islands (Sand 1998b) (Fig. 10). Objects like the 'hache ostensoir' and the sling stones, associated with the Oundjo and Nera types of pottery, can without question be classified as part of what could be called the 'Kanak Cultural Complex', a set of local characteristics, shared throughout the archipelago, that differentiated the indigenous inhabitants from their regional neighbours (Sand et al. 2000). Oral traditions and ethnographic accounts have shown how much the spread of items through the islands depended on the relationships between different specialist groups who produced exchangeable valuables. Nephrite discs were polished on the Grande Terre to be sent to the Loyalty Islands, which in turn produced special shell ornaments or tools for coded exchange (Guiart 1963; Leenhardt 1937; Sand 1995a). The settling of small foreign groups, mostly from West Polynesia, led in some areas to complex specialisation strategies (Carson 2000). All these characteristics were at work in the archipelago when the first European ships entered New Caledonian waters at the end of the 18th century, bringing in new items and putting an end to the 'prehistory' of New Caledonia. The 'first contact' is visible in rock shelter stratigraphy by the sudden intrusion of glass flakes, glass beads and iron objects, and the abrupt disappearance of flaked stone artefacts.

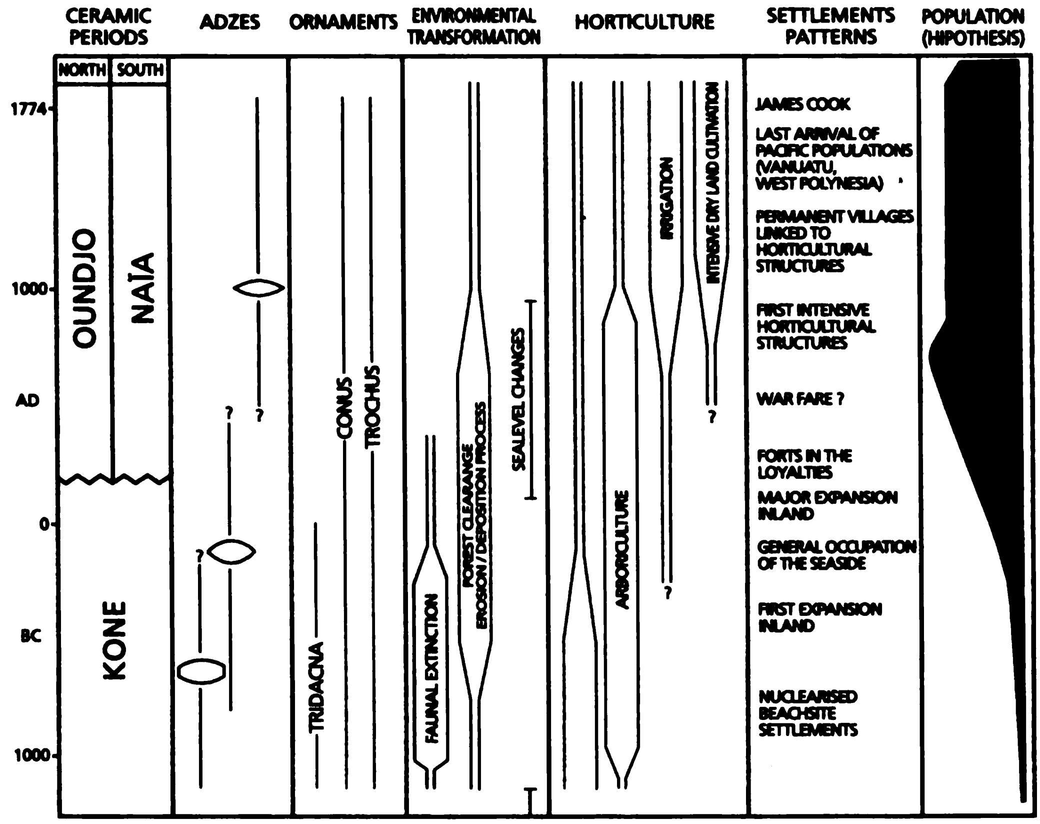

Fig. 10. Synthesis diagram of the prehistoric chronology of New Caledonia.

'Deconstruction' of prehistoric chronologies in Pacific perspective: A short comment

The kind of 'deconstruction' of the chronology proposed in this study has clearly shown different chronological 'periods' in the prehistory of New Caledonia, succeeding each other through processes of cultural change and evolution, in a classic historical framework. But how does this type of work fit into a wider perspective, in relation to the claims of reappropriation of their past by Pacific peoples? Trained in Western concepts, most archaeologists working in Oceania have no problem in dividing local prehistories into periods, but face problems with modern boundaries (see Green 1991; Spriggs 1992). In universities, students are taught chronologies divided for Northern Europe, for example, between the Celts, the Gallics, the Gallo-Romans, the Francs and Normans, before finally the French, English and Welsh. Identifying, after the middle of the prehistoric sequence from New Caledonia, the appearance of thoroughly Kanak characteristics which can be clearly related to the ethnographic data, and that people naming themselves as Kanaks today recognise explicitly as their own and unique particular culture has led me to use the term 'Kanak Cultural Complex'. *Sensu stricto*, this means that what was before was not explicitly Kanak, as the Gallics were not explicitly French but just their ancestors. But for a fair number of present-day Kanaks, saying this makes them feel as if archaeology was stealing part of their past, as if the early part of prehistory was not 'Kanak'. But can Lapita pottery, for example, not made in New Caledonia for nearly 2800 years, be called 'Kanak'? To Western-trained minds, the answer would be negative. But when Egyptian archaeologists, Muslim and Arabic, dig out pharaohs 5000 years old and speak of them as 'our Egyptian ancestors', they do exactly this: claim the right to name history in their own words, without the semantic divisions developed for Europe by European scholars.

This problem, that at first might seem minor, could become a major issue in the decades to come in Pacific island archaeology. Because the idea of social, cultural and political evolutions are not part of the way most traditional Melanesian people see their past, now that indigenous leaders will control part or all of what will be written about their old history, what choices will be made (Spriggs 1991)? And what words will archaeologists use? Is Lapita Kanak (Bensa 1990), or is Lapita the oldest and first ancestor of a later culture that is labelled Kanak (Sand 2000b)?

Conclusion

This synthesis of the non-ceramic artefacts found in the prehistoric sites of New Caledonia, whose number has been significantly augmented during the last decade, shows a marked development from the conclusions made on the subject 20 years ago. Once described as "remarkably few" by Green and Mitchell (1983), the non-pottery artefacts have been convincingly increased, and it appears that we can now identify changes in their chronology. Some items, as Green once said, "have changed very little in 3000 years" (Green and Mitchell 1983:64). Also, nowhere do we have any abrupt change or any sign of an abrupt replacement, parallelling what is known for the ceramic sequence. But what we have is the presence of a reasonable number of artefacts that drop out of the manufacturing kit at various stages, or appear at one period, often it seems as local creations. This diversified picture parallels remarkably the general prehistoric sequence for New Caledonia, as proposed in recent syntheses (Sand 1995a, 1996b, 1999d). Probably the most interesting result is the clear appearance of new items starting during the late part of the first millennium AD. Chronologically, it is at that moment that we can archaeologically identify the formation of what could be termed the 'Kanak Cultural Complex' (Sand et al. 2000), the basis of the societies witnessed by the first Europeans in New Caledonia.

Notes

1. Most of the non-ceramic artefacts found by teams other than the Department of Archaeology and listed in this paper are in unpublished reports. As much as possible, I have tried to give with each reference the exact page or figure of the artefacts described, but to avoid any 'ownership' problem, it was decided to illustrate only material discovered or published by the Department of Archaeology.
2. I have not included in this paper artefacts of European origin present in traditional early historical sites (1774–1850) and used in indigenous ways, like flaked glass and coloured beads. For the shell ornaments, the typology proposed by P.V. Kirch (1988) for Lapita shell artefacts was used.

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Arapus: A Lapita site at Mangaasi in central Vanuatu?

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Introduction

The Mangaasi site, excavated by Jose Garanger in the mid-1960s, has a justifiably iconic status amongst Pacific archaeologists (see Fig. 1 for location). The size of the excavation alone, some 118 m^2, has rarely been matched since in the Pacific. The level of detail presented and the copious illustrations of the artefacts recovered have not yet been equalled by any subsequent Pacific archaeological publication (Garanger 1972, 1982). It is the type site for Mangaasi pottery, the classic incised and applied-relief pottery of central Vanuatu which has often been compared to at least superficially similar ceramic assemblages from the New Guinea mainland through to Fiji (e.g. Spriggs 1984, 1997; Wahome 1997, 1999). Bedford and Clark (this volume) present a different evaluation of the putative similarities among these assemblages. Here we concentrate on the site itself and eschew most outside comparisons.

Garanger's proposed Mangaasi pottery sequence began at 2700 to 2500 BP and lasted, he thought, through to about the 17th century AD at the site. Excavations at Erueti, another site on Efate, convinced him that Mangaasi was the earliest and dominant pottery tradition and that Lapita pottery was here intrusive into a Mangaasi world, a Melanesian environment with links back to New Guinea. At the Erueti site there were occasional sherds of Lapita pottery found both in the deposit and on the surface, and a Lapitoid style of pottery, named by Garanger "Erueti ware", was found in association with ceramics of the Mangaasi style. A single radiocarbon date of about 2350–2200 BP in seeming association with the Lapita pottery at Erueti was the basis for Garanger's view of Lapita intrusion.

The very detail which Garanger presented in his report has allowed for re-evaluations of the data based on further research. Graeme Ward first challenged the dating of ceramics at the Mangaasi site (Ward 1979, 1989), believing that pottery production ceased much earlier than Garanger had suggested in 1972, perhaps in the early centuries AD. This idea was based on a detailed reanalysis of the published stratigraphy and associated dates. He also drew support from a comparison of the Mangaasi ceramics with those recovered from his own excavations at the Pakea site in the Banks Islands, the main deposit of which dated to about 2200 BP.

Subsequently Garanger has gracefully accepted Ward's criticism of a 17th century AD date for the end of pottery making at Mangaasi, writing (1996:70):

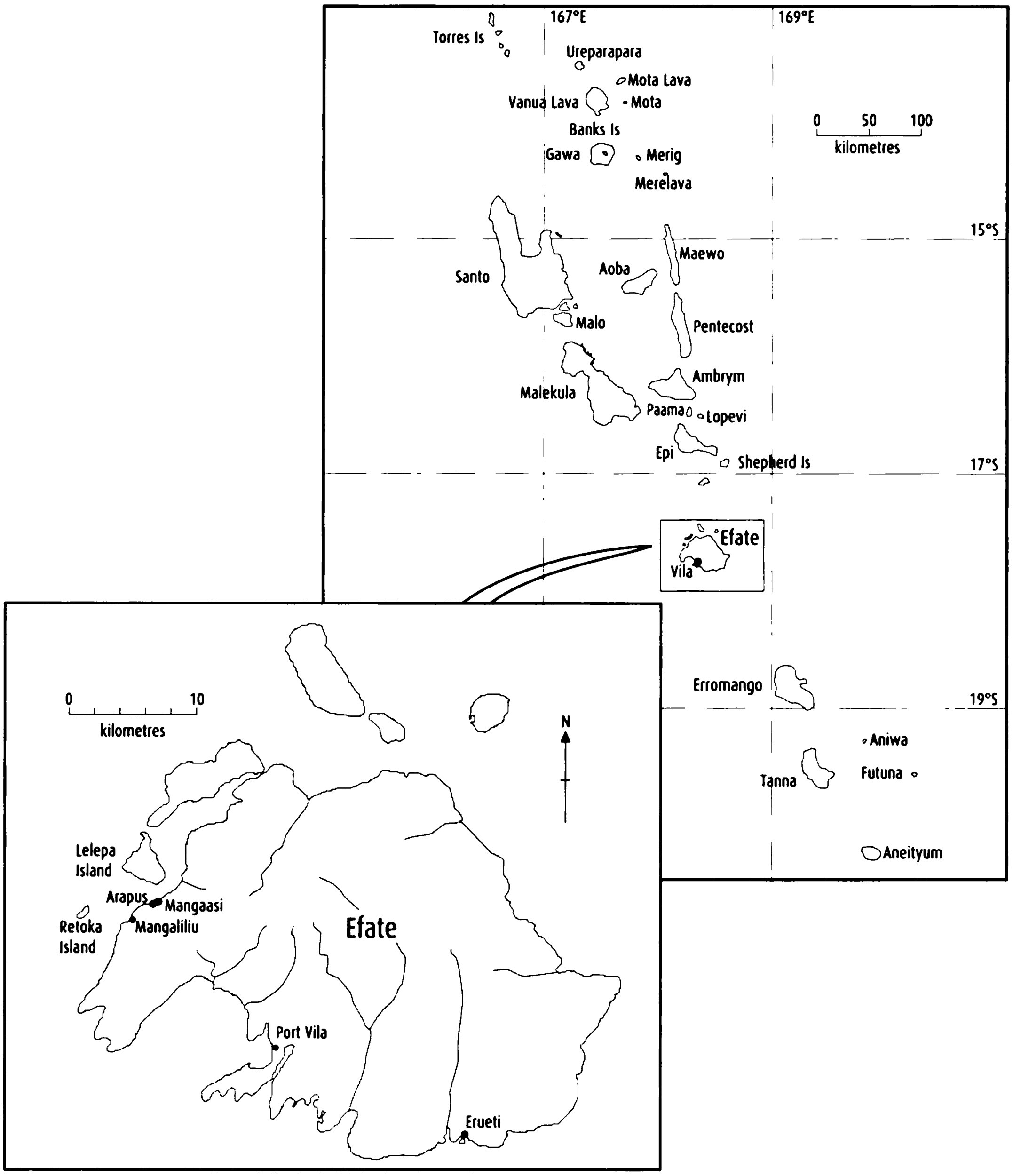

Fig. 1. Vanuatu (top) and Efate.

"I agree with him today. The site's stratigraphy is too complex in the later levels for us to be certain of their chronology. It is most likely that the loss of pottery was much earlier here, as it was elsewhere in the central part of the archipelago. New excavations on a site close to Mangaasi but less disturbed should be able to confirm this."

Spriggs (1997:140–141, 179–181) also made a reassessment of the Mangaasi site evidence. He considered the Erueti site to be disturbed and so dismissed the association between the Lapita pottery and the 2350–2200 BP date, and asserted the primacy of Lapita in Vanuatu. He saw the Mangaasi-style pottery as developing from Lapita about 2700–2500 BP (cf. Spriggs 1984). Spriggs reinterpreted the stratigraphy of the site to provide a further line of evidence that pottery making ceased in the early centuries AD, based on an association with the date of the Ambrym caldera forming event, one of the 10 largest eruptions in the world in the last 10,000 years (Robin et al. 1993).

Garanger had interpreted an upper marine deposit at the site (Layer IIa) with the 1452 AD eruption of the Kuwae volcano (another one of the top 10: Eissen et al. 1994; Robin et al. 1994) and attendant tidal waves. The lower marine deposit (Layers IIc and IId) were associated by Garanger with a period of subsidence, but this interpretation seemed unlikely given the geological history of Efate, which is one of uplift rather than subsidence in recent times (Ash et al. 1978). Spriggs suggested a comparable explanation for Layers IIc and IId as IIa, that they related to tidal waves associated with the Ambrym eruption of around 1850 BP. Accepting Ward's criticism that pottery above the marine levels was unlikely to be in primary stratigraphic position, he placed cessation of pottery use as being prior to the Ambrym-associated layers.

Between 1996 and 1999 a joint Australian National University–Vanuatu National Museum research and training program was carried out at the site of Mangaasi and an adjacent site known as Arapus. The excavations have substantially altered perceptions regarding both the nature of initial human settlement in Vanuatu and its later transformations. It is these new excavations, called for by Garanger (1996) to settle the chronological issues, that we will now turn to. They require revision of Garanger's original sequence and also of Ward's and Spriggs' postulated revisions to that original sequence.

The results from Mangaasi have also been supplemented with a series of excavations on a number of other islands throughout the archipelago by Bedford and Spriggs (Bedford 2000a; Bedford et al. 1998), and there has been further research by Galipaud in northern Vanuatu (1998). There seems little doubt now that Lapita dentate-stamped ceramics are associated with the initial colonisers of Vanuatu, including of course Efate, around 3000 BP. Plain ware ceramics are found in association with Lapita and continue in use after its disappearance on various islands investigated to date. Soon after Lapita the ceramic sequences of the various islands begin to diverge.

The Mangaasi and Arapus excavations 1996–1999

Some treatment of the 1996 and 1997 seasons has been published (Bedford 2000b; Bedford et al. 1998), while information on the 1998 field season has previously only been available as a web site (http://artalpha.anu.edu.au/nobarriers) and as part of an unpublished report to the Vanuatu government (Spriggs and Bedford 1999). The 1999 season is discussed in a recent article (Bedford and Spriggs 2000). Greater detail for all seasons can be found in Bedford's thesis (2000a), but we summarise here the progress of excavations during the four years of the project.

Four 1 m by 1 m test pits (TP 1 to 4) were excavated in 1996 across the Mangaasi site to identify the layers that Garanger had reported. Three of these test pits were placed near the area where Garanger had worked and confirmed the presence of the ceramic-bearing layers sitting on top of a beach deposit at some 1.4–1.6 m below the ground surface. However, when digging through the beach deposit in an attempt to locate the ancient reef many pieces of worn pottery and charcoal were found. The reef was finally found at 3.6 m below the present surface and at least 2 m above the level of the reef of today. This indicated two things: first, that the island of Efate has been continuously subject to uplift for thousands of years due to tectonic activity, and second that the worn pottery in the old beach deposits suggested an earlier village was located further inland. A last test pit (TP 4) was dug further inland and during the final days of the work the remains of an earlier village were found. This area of the site had not been affected by tidal wave action and was much better preserved. The remains of cooking fires, pots, shellfish and animal bone were recovered. Also found were *Tridacna* shell adzes, and shell ornaments such as beads, arm rings and earrings. The pottery from the bottom of this test pit was of Garanger's Erueti style.

The results of the 1996 season clarified a number of questions but also highlighted the need for further work at the site. The remains of the earliest settlement had been found a considerable distance inland but several thousand years ago it would have been close to the sea. People were living immediately inland of the beach and discarding midden materials such as broken pots, bone and shellfish into the sea below the high-tide mark. As the island was periodically uplifted, people shifted their villages so they could continue living adjacent to the sea.

The work of 1997 followed on from that of 1996. The location of Garanger's earlier excavation had been fixed, and work could concentrate on trying to find out more about the earlier village with its Erueti-style pottery. How it related to the later village and the Mangaasi-style pottery was a major research focus. A total of seven test pits in all were excavated in 1997 (TP 5 to TP 11). They were again 1 m by 1 m test pits (although TP 9 was later enlarged to a 2 m by 2 m area) which located deep (up to 2 m) cultural deposits which had not been disturbed. The evidence from this work confirmed what had earlier been suggested, that the archaeological stratigraphy of the site was both horizontal and vertical. The earliest remains were to the south (inland) and later occupation evidence was generally to the north (seaward). Where their distribution overlapped, the earlier remains were stratigraphically below and sealed in by the later ones. This established the primacy of Erueti-style pottery in the cultural sequence at Mangaasi, thus overturning Garanger's earlier sequence of styles. Erueti-style pottery was found in test pits almost 50 m further inland from Garanger's original excavations. The main area of habitation was concentrated along the bank of the Pwanmwou stream and on the old beach ridge above the high-tide mark, and shifted as the beach prograded.

Two tephra layers were also clearly identified in the test pits of 1997. The lower one did not occur in the area excavated in 1996 which would have been offshore at the time, and the upper one was mixed with later deposits and unrecognisable in the field. It was mainly laid down as a secondary deposit washing off the steep slopes behind the site. Thus it thins out seawards and becomes mixed with later deposits of Garanger's Layer I in the area of his excavation. These tephras were ash deposits from the very large volcanic eruptions on Ambrym around 2000 years ago and Kuwae in the Shepherd Islands some 500 years ago. In some of the test pits these were thick layers which sealed the evidence of the older occupation layers and could be used to cross-date different areas of the site. The Erueti-style pottery was only found underneath the earlier Ambrym ash while the Mangaasi-style pottery was sandwiched between the two ashes. It should be noted that there was no connection between the marine layers identified by Garanger and either of the eruptions represented by the tephras. The marine layers may represent unrelated tsunami events or cyclonic storm surges.

A further 6 sq m (TP 12 to TP 17) were opened up in 1998 with the aims of: first, defining the limits of the site in relation to the stream channel; second, further understanding the complex stratigraphy with its pattern of tidal-wave or storm-wave deposits and volcanic ash falls; and third, increasing the sample of artefacts and other remains from both the earliest and the latest periods of occupation.

The first aim of finding the boundaries of the site was successfully achieved for areas closest to the stream at the western edge of the site and in relation to the north-south transect from TP 1 to TP 13. We were unable to define further the site boundaries to the east because the area was being gardened at the time. This meant that the eastern extent of the earliest occupation, centred in a band between beach and stream in the TP 9 and TP 4 area, was not clearly established. This was later achieved with the excavation of TP 18 in 1999 (see below). TP 12 was a seaward extension of the earliest deposit. The pottery was found to 4 m below the surface in the beach sands under the occupation levels. This showed that TP 12 was not part of the earliest occupation in this area and had been in the inter-tidal zone when the site was first inhabited. The seaward edge of the earliest occupation occurs somewhere between TP 12 and TP 10.

It would seem that people either avoided settling too close to the stream because of flooding concerns, or that any such settlement has been destroyed by subsequent stream action in the TP 13 and TP 14 areas. The pattern was clearly one of settlement following the advancing shoreline, while staying close to the stream. The latest pottery-using occupation of ca. 1500–1200 BP was, however, more dispersed across the landscape than the earlier settlement site.

The second aim was also achieved, but revealed further complexities in the sequences of events in different areas of the site. The tidal-wave layer which was Garanger's Layer II continues as a substantial deposit into the TP 17 area but may be represented by only a thin 'flood' deposit of sand in TP 10. This tidal-wave layer is clearly not the same flood deposit as that found in TP 12. This is because there were very different kinds of pottery in TP 12 (Erueti style) and TP 10 (Early Mangaasi style) immediately above the similar-looking flood layers in the two test pits. The flood layer in TP 9 may be earlier still.

TP 13 and TP 14 revealed different episodes of alluvial fill from flooding of the stream. TP 13, although it was upstream, was closer to the current stream channel and its alluvial fill contained late (Mangaasi-style) pottery. TP 14 was downstream but was at a higher elevation relative to the stream at that point. It contained earlier marine deposits under the alluvial fill. Clearly the stream has been very active in the past, cutting down and then filling in again. The TP 13 evidence suggests that it was very near the stream mouth, or at least was subject to marine incursion or influence. On the evidence of these two test pits it would seem that stream-flood deposits would not consist of marine-type sands but of a lot more muddy material from upstream. Thus the 'flood' deposits such as were seen in TP 9 in 1997 are more likely to result from wave action than from stream flooding as had been our earlier interpretation.

The third aim of increasing our sample of cultural material from the earliest and latest periods of use of the site was also successful. The TP 12 excavation provided a greatly increased sample of shell ornaments from early occupation levels of about 2500 years ago. TP 15–17 have greatly increased our sample of late-style pottery associated with occasional applied-relief decorated pottery and pottery handles. There was comparatively little other material culture associated with these late pottery-bearing layers which date to about 1500 to 1200 years ago. Occasional *Tridacna* shell adzes and some volcanic glass flakes made up most of this material.

The 1998 field season continued the training program for the Vanuatu National Museum, but as well as the field workers and National Museum staff, some training of students back in Canberra at the Australian National University was also undertaken. This was done by setting up a web site to which information, including photographs, was posted using a computer link via a satellite phone. Students were able to respond via an email network. This part of the project was funded by a grant to Spriggs from the Kon-Tiki Museum and Telenor, Norway, and further assistance in the form of an equipment loan from the Apple University Development Fund. The web site is still accessible at the address given above, and an assessment of this part of the project has recently been published (Spriggs 1999).

The research focus in 1999 was to investigate the area southwest of the Pwanmwou Creek (Fig. 2) for any signs of early human settlement similar to that found at Mangaasi. We gave the general name Arapus to this area, after one of the smaller named parcels of land within it. One last test pit (TP 18) was also excavated at Mangaasi to fill in the grid pattern of investigation. It confirmed the results of the previous years' work, that the earliest settlement at Mangaasi was restricted to a small area near the stream.

Slightly different excavation techniques were used on many of the test pits on the southwest side of the creek. During the 1996–1998 excavations much finer techniques of excavation and artefact recovery were used. All the test pits were trowelled in generally 10 cm-thick spits within natural stratigraphic layers as the complicated stratigraphy at the site was not well known. All excavated earth was sieved both dry and then wet with total samples of all classes (charcoal, shell, stone, bone, pottery) of remains being collected. By 1999 the stratigraphy of the area along with the ages of the different pottery styles were well known, thereby enabling us to excavate by layer. Although all test pits were trowelled there were only a select few where all of the soil was sieved. Pottery and other artefacts were collected during excavation. Only small samples of the shellfish were collected, with the rest being discarded.

A grid of test pits spaced generally at 25 m intervals was laid across the site, oriented to the cardinal points. This was an extension of the same grid system utilised at Mangaasi. This side of the river had also been more recently used as a village and many low coral boundary walls were seen across the site. Land ownership today relates to the old household boundaries and involves ownership of small parcels of land. This required constant changing of the local excavation crews so that landowners were also involved in the work, and occasional variation to the grid when a landowner was unwilling for us to dig on his plot. A total of 23 1 m by 1 m test pits were excavated during the six-week season, extending more than 150 m southwest of Pwanwmou Creek.

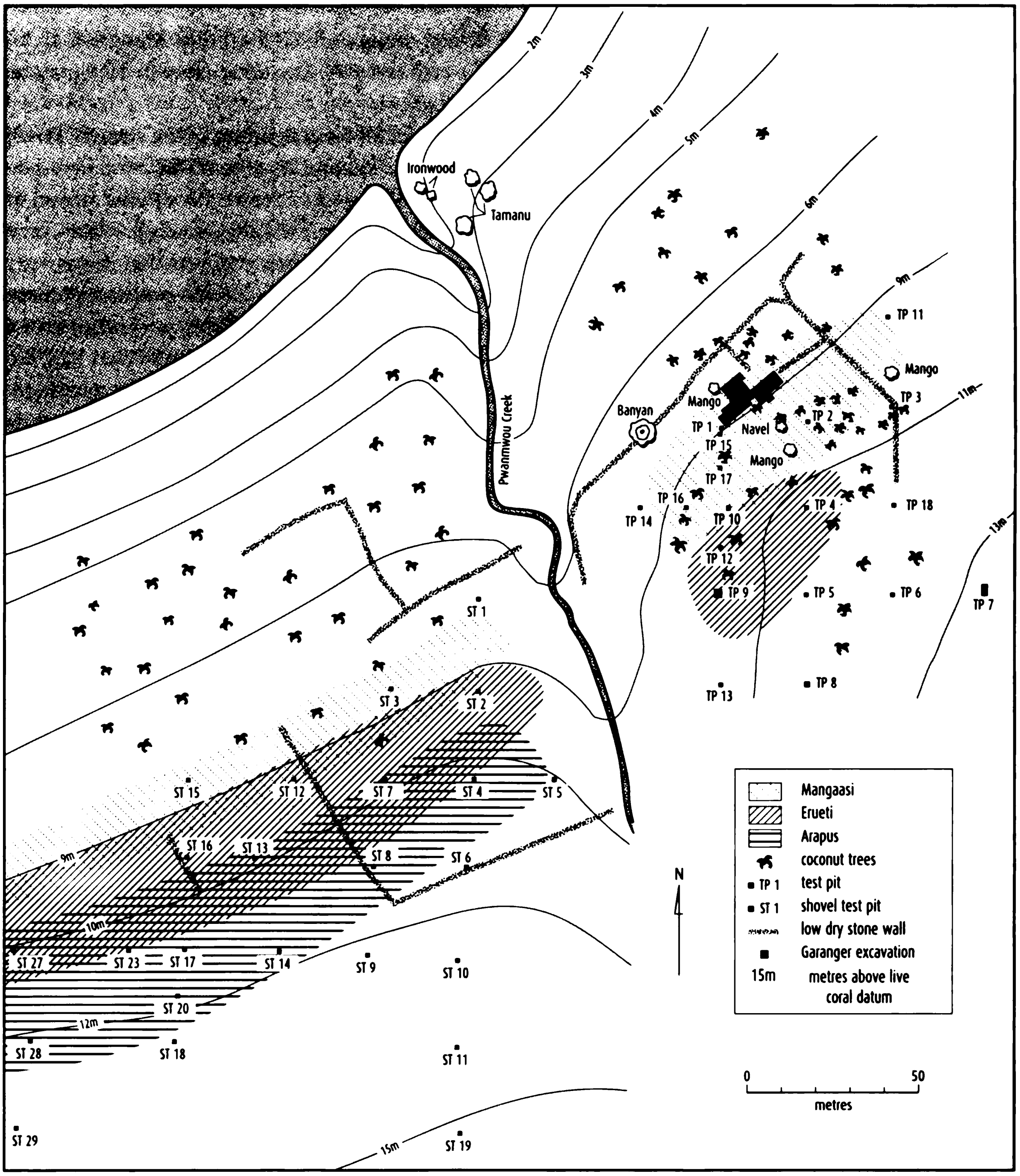

Fig. 2. Arapus (left of creek) and Mangaasi (right of creek), Efate.

We have recently published some details of the 1999 excavations in the Arapus area across the Pwanwmou Creek, which reveal that Mangaasi is actually the northeastern end of a much larger site complex, which extends an unknown distance to the southwest (Bedford and Spriggs 2000). We will, therefore, only briefly summarise the results here.

The evidence for the initial human habitation of the area is concentrated along a former beach ridge now located some 10–11 m above present high-tide mark. Test pits excavated across this broad strip parallel to the now distant foreshore revealed a consistent pattern of stratigraphy and archaeological remains for 125 m or so. The first 20 cm or so of the lowest levels of the test pits associated with human activity consistently comprised of concentrated very large shellfish, with a preference for *Trochus maculatus*. Also amongst the shellfish were concentrations of bone, including that of fish, bird, flying fox, turtle and land crocodile. Pottery was relatively sparse. This evidence gives a glimpse of a short time period where a population on initial arrival were for a short period heavily reliant on readily procurable local marine and terrestrial resources. Two radiocarbon determinations (see Table 1) on large *Trochus maculatus* from this lowest level in ST 14 and 17 respectively indicate that people first arrived in the area around 2900 years ago (ANU 11159 and ANU 11160).

Table 1. Conventional radiocarbon dates from Mangaasi and Retoka associated with ANU-Vanuatu National Museum Archaeological Project 1996–1999.

LAB NUMBER	AGE BP	MATERIAL	CALIBRATED AGE BP (2 S.D.)	SITE AND CONTEXT
ANU-10658	2380±60	charcoal	2711 (2353) 2213	Mangaasi (TP 4, 170–190 cm bd)
ANU-10659	2520±60	charcoal	2754 (2712,2625,2623) 2357	Mangaasi (TP 4, 210–230 cm bd)
ANU-10657	2410±60	marine shell	2161 (2020) 1876	Mangaasi (TP 4, 110–130 cm bd)
ANU-10656	220±60	charcoal	431 (288) 0	Mangaasi (TP 4, 70–85 cm bd)
ANU-10655*	3690±60	marine shell	3723 (3590) 3443	Mangaasi (TP 3, 220 cm bd)
ANU-10649*	98.5±1.5%M	charcoal	modern	Mangaasi (TP 3 90–100 cm bd)
ANU-10650	2220±130	charcoal	2708 (2303,2240,2205, 2200, 2181, 2166,2162) 1897	Mangaasi (TP 3, 130–140 cm bd)
ANU-10651*	6190±80	charcoal	7268 (7156,7124,7090,7063, 7029) 6807	Mangaasi (TP 3, 150–160 cm bd)
ANU-10652	2850±50	marine shell	2727 (2663) 2429	Mangaasi (TP 3, 170 cm bd)
ANU-10653*	130.0±2.4%M	charcoal	modern	Mangaasi (TP 3, 170–180 cm bd)
ANU-10654	2290±100	charcoal	2710 (2336) 2044	Mangaasi (TP 3, 210–230 cm bd)
ANU-10648	330±60	charcoal	510 (428,377,323) 160	Mangaasi (TP 3, 30–50 cm bd)
ANU-10647	490±60	charcoal	629 (520) 463	Mangaasi (TP 3, 25–30 cm bd)
ANU-10646	1660±90	charcoal	1816 (1543) 1349	Mangaasi (TP 2, 120–130 cm bd)
ANU-10644*	103.3±1.0%M	charcoal	modern	Mangaasi (TP 1.2–1.3)
ANU-10641*	106.5±2.4%M	charcoal	modern	Mangaasi (TP 1, 110–130 cm bd)
ANU-10640*	1310±130	charcoal	1509 (1263) 953	Mangaasi (TP 1, 70–90 cm bd)
ANU-10642*	3040±140	charcoal	3566 (3315,3312,3257) 2851	Mangaasi (TP 1, 160–170 cm bd)
ANU-10643	2480±60	marine shell	2295 (2120) 1958	Mangaasi (TP 1, 160–170 cm bd)
ANU-10645*	1050±60	marine shell	698 (620) 517	Mangaasi (TP 1.2–1.3)
ANU-10801	2180±130	charcoal	2467 (2291,2273,2151) 1871	Mangaasi (TP 9, 60–80 cm bd)
ANU-10802	2960±140	charcoal	3468 (3158,3149,3140,3126,3112, 3089,3080) 2776	Mangaasi (TP 9, 90–100 cm bd)
ANU-10803	2550±110	charcoal	2855 (2735) 2347	Mangaasi (TP 9, 95–105 cm bd)
ANU-10800	2550±130	charcoal	2921 (2735) 2336	Mangaasi (TP 9, 155–165 cm bd)
ANU-10798	2420±80	charcoal	2744 (2428,2420,2394,2360) 2214	Mangaasi (TP 9, 175–185 cm bd)
ANU-10796	3050±80	marine shell	2990 (2790) 2695	Mangaasi (TP 9, 195–205 cm bd)
ANU-10799	2790±110	charcoal	3236 (2915,2913,2870) 2741	Mangaasi (TP 9, 195–205 cm bd)
ANU-10797*	1350±180	charcoal	1685 (1287) 927	Mangaasi (TP 9, 205–215 cm bd)
Wk-6602	2820±50	marine shell	2716 (2603) 2359	Mangaasi (TP 9.4, 80–100 cm bd)
Wk-6603	2790±50	marine shell	2720 (2496) 2344	Mangaasi (TP 9.4, 110–130 cm bd)
Wk-6598	2670±50	marine shell	2473 (2336) 2280	Mangaasi (TP10, 110–120 cm bd)
Wk-6599	2740±50	marine shell	2665 (2428) 2321	Mangaasi (TP10, 140–150 cm bd)
Wk-6600	2910±45	marine shell	2755 (2708) 2601	Mangaasi (TP10, 150–160 cm bd)
Wk-6601	3160±50	marine shell	3077 (2937) 2805	Mangaasi (TP10, 180–190 cm bd)
ANU-11158*	2020±110	charcoal	2310 (1987,1979,1970,1960,1950)1710	Arapus STP 8 (190–200 cm bd)
ANU-11159	3200±50	marine shell	3152 (2985) 2853	Arapus STP 17 (140 cm bd)
ANU-11160	3010±50	marine shell	2868 (2759) 2706	Arapus STP 14 (160 cm bd)
RETOKA				
ANU-10257	720±70	marine shell	485 (330) 245	shell ornament from Roy Mata burials

* Denotes dates that are anomalous and have been rejected as unreliable.

All dates have been calibrated using the Calib. Program REV 4.1.2 of Stuiver et al. 1998 with delta R as 0 for marine samples.

Rapid change in the above situation is indicated by the appearance of concentrated pottery and cooking stones with a decrease in the quantity of shellfish and bone. The pottery consists of a distinctive type of cooking vessel, namely plain globular pots with out-curving rims which are almost always notched on the lip. This pottery has been named the Arapus style. It is notable for its homogeneity. The fabric of the pots appears to be identical to the later Erueti-style ceramics of the site which on petrographic grounds (Dickinson 1997) indicated an Efate origin and were probably made on site. The only anomaly amongst the Arapus material was a plain carinated body sherd which was substantially thinner and composed of a fabric with much more concentrated volcanic temper. Other artefacts associated with the Arapus ware were *Tridacna* shell arm rings and hinge-region adzes and a grooved sea-urchin spine — an artefact type usually found only in Lapita sites (cf. Spriggs 1984:219).

Erueti-style pottery always stratigraphically overlays Arapus ware and clearly developed from it. The out-curving Arapus rims became increasingly horizontal in form, transforming into the distinctive wide flat lips that characterise the later Erueti pots. There is, as mentioned, a continuity in the composition and texture of the fabric along with other artefact forms.

The tephra layers noted at the Mangaasi site were also present here. Arapus and Erueti-style pottery was only found underneath the earlier Ambrym ash while the Mangaasi-style pottery was sandwiched between the two. What also became apparent during the excavations at Arapus was the presence of a third, as yet unidentified, ash, directly underlying the initial human occupation of the area. Samples have yet to be analysed but it is hoped they will identify the source and timing represented by this lower deposit of ash.

Summary of four seasons at Mangaasi

1. Excavations inland and to the southwest of the area excavated by Garanger at Mangaasi have produced earlier and more intact cultural deposits than previously sampled, extending back to ca. 3000 BP. The Mangaasi site itself represents the periphery of a much larger site extending to the southwest across the Pwanmwou Creek.
2. The earliest deposits — whose extent to the southwest has not yet been defined and will be the subject of further research — are contemporary with Lapita deposits elsewhere in Vanuatu and are interpreted as a plain ware cooking-pot component of a Lapita site. Non-ceramic material culture is similar to that found in Lapita sites. We note a possible parallel here with New Caledonian Podtanean sites which are sometimes claimed as complementary in distribution to dentate-stamped Lapita (Sand 1995).
3. The earliest component of the site at Arapus (ca. 3000 to 2800 BP) represents an initial colonising site for this part of Efate. The presence of concentrated bone (including extinct species), extremely large *Trochus* shells and a scarcity of pottery and fish bone in the lowest levels supports this hypothesis.
4. Extinct species found in ca. 3000 BP layers include a Mekosuchid land crocodile identified by Jim Mead (University of Tucson). Among the birds identified by Dave Steadman (University of Florida) were a locally extinct hawk (still extant elsewhere in Vanuatu) and an extinct megapode form. All are clearly part of midden remains. It should be noted that some of these deposits were not screened. Later deposits at Mangaasi (which were wet screened through 1 mm mesh) contain almost entirely extant forms of birds, except for a locally extinct kingfisher (again still found elsewhere in Vanuatu) and a sea bird now extinct in Vanuatu but found elsewhere in the Pacific. Both occur in Mangaasi levels later than 1850 BP and represent isolated specimens.
5. Chicken occurs from earliest levels at Arapus, pig is found from at least the Erueti levels onwards and our faunal sample from the earlier Arapus levels is not of sufficient size to say whether it is present or not there — certainly it occurs at other Lapita-age sites in Vanuatu in firm contexts. No dog remains have been found at the site.

6. *Rattus praetor* is found in early Erueti levels only, but the same caveat as regards pig needs to be made as far as Arapus levels are concerned. It is also found in early Malekulan sites but not on Erromango to the south (see White et al. 2000). *Rattus praetor* is now extinct in Vanuatu. *Rattus exulans* is also found in the site from the earliest levels and remains extant today in Vanuatu.
7. The early prehistoric settlement pattern focused on beach ridges above and parallel to the foreshore, which was continually prograding over time. We envisage for pre-Mangaasi periods a single row of houses parallel to the beach as the settlement pattern. The late Mangaasi settlement pattern may represent more dispersed, low-density settlement across the landscape. This also seems to be the post-Kuwae eruption and pre-European settlement pattern in the area.
8. The non-ceramic artefact sample suggests continuity of form from Arapus levels through to Mangaasi, albeit with a diminution in variety of shell ornaments. This parallels the descent with modification seen in the pottery styles during this period, but shows shell ornament types to be more conservative than pottery styles.
9. The Central Vanuatu cultural sequence from ca. 3000 to about 1200 BP has been significantly clarified and is clearly contrasted (as Garanger had done) with the aceramic 600 BP to European contact sequence. As predicted but certainly not demonstrated in the 1980s by Spriggs (1984), Mangaasi is a transitional site, having a Lapitoid plain ware component and a continuous sequence through to the incised and applied-relief ceramics associated with the Mangaasi style. Pottery from all levels is locally made according to analysis by Dickinson (1997), and clay wasters were found during the 1967 and 1990s excavations, providing further indication of manufacture on site.
10. The dating of these stylistic transitions has been refined (see Tables 1 and 2 for a listing of all Mangaasi and Arapus radiocarbon dates). The previous proposal of Garanger for two separate, early and contemporaneous populations in Vanuatu — Mangaasi and Lapita — has been rejected in favour of an initial Lapita occupation at about 3000 BP. The plain ware component of this occupation included Arapus-style pottery. There was a transition from this to Erueti Ware at about 2800 BP, a further set of changes producing Mangaasi-style pottery by 2000–1800 BP, and the end of pottery production on Efate at around 1200 BP — although this end of the ceramic sequence is not at present well defined.
11. While it is possible that pottery continued in use somewhat later at some other Efate sites (cf. Spriggs 1997 referring to Shutler and Shutler's (1966) Fila Island excavations), the evidence from the wider central Vanuatu region is that it was not being made or used immediately after the Kuwae eruption of 1452 AD. At the Mangaasi site itself, post-Kuwae reoccupation around 1600 AD was certainly aceramic. This later material culture is linked to oral histories which suggest major changes to Central Vanuatu social structure and populations perhaps beginning around 1200 to 1000 BP and attendant upon significant Polynesian contacts (Luders pers. comm.). There is currently a gap in central Vanuatu sequences from about 1200 or 1000 BP to about 600 BP which may reflect the realignments in social organisation believed to have taken place during that period.
12. Oral traditions state that the Mangaasi site was the village of the legendary chief Roy Mata and there seems no reason to dispute these detailed accounts. They refer, of course, to the post-Kuwae aceramic occupation dating to about 1600 AD (ANU-10647, ANU-10648 and ANU-10656), visible on the surface as a series of low walls across the site which delineate house areas, dancing grounds and so on. The location of the site above the Kuwae ash and the late dates for occupation seemed to contradict the dating of the supposed grave site of Roy Mata on nearby Retoka Island by Garanger to about 1265 AD (Garanger 1972). But this original dating was on human bone and was considered unreliable. Garanger has since supplied us with samples of shell ornaments for dating from the grave site which are in broad agreement with the Mangaasi aceramic occupation dates (samples OZC784, OZC785, ANU-10257 from Retoka) to support a post-Kuwae antiquity for this chief.

We plan to continue research in the Mangaasi–Arapus area to define the southwestern limits of the site and to increase faunal and material–cultural suites from the earliest levels. Spatial differentiation within the Arapus site is also an important issue. We have found the cooking and food

Table 2. AMS dates from Mangaasi and Retoka associated with ANU-Vanuatu National Museum Archaeological Project 1996–1999.

LAB. NO.	AGE BP	MATERIAL	CALIBRATED AGE BP (2SD)	SITE AND CONTEXT
EFATE				
OZC829	2340±50	charcoal	2467 (2347) 2208	Mangaasi (TP 2, 210–220 cm bd)
OZC830	2450±50	charcoal	2736 (2485,2481,2469) 2348	Mangaasi (TP 3, 270–290 cm bd)
OZC831	2090±50	charcoal	2297 (2043) 1928	Mangaasi (TP 4, 110–130 cm bd)
OZD580	1670±60	charcoal	1710 (1553) 1413	Mangaasi (TP 7, 145–170 cm bd)
OZD581	2540±50	charcoal	2753 (2728) 2363	Mangaasi (TP 7, 270–290 cm bd)
OZD582	2580±50	charcoal	2776 (2743) 2492	Mangaasi (TP 9.4, 180–190 cm bd)
OZD578	2250±60	charcoal	2353 (2312,2218,2211) 2119	Mangaasi (TP 10, 90–100 cm bd)
OZD579	2620±110	charcoal	2950 (2750) 2357	Mangaasi (TP 10, 190–200 cm bd)
RETOKA				
OZC784	690±80	marine shell	479 (300) 136	shell ornament from Roy Mata burials
OZC785	990±125	marine shell	762 (550) 386	shell ornament from Roy Mata burials

consumption areas of the site, but have yet to find the dentate-stamped pottery one would expect in such a site of Lapita age. Were we to find it to the southwest it would suggest that Lapita is indeed a specialised, perhaps ritual and/or high-status ware. If instead we find the spatial limits of the early occupation and no dentate-stamped pottery, then we would be faced with a situation similar to that in New Caledonia where Lapita and Podtanean pottery-using settlements are contemporaneous but spatially separate (Sand 1995). Further issues of class, religious affiliation and perhaps ethnic differentiation would all then have to be raised. We do not yet know if the Mangaasi–Arapus site will turn out to be a location of classic Lapita settlement. But as originally established by Garanger, it is certainly one of the classic archaeological sites of the Pacific and one that clearly has considerable further potential to elucidate important questions relating to Vanuatu and Pacific archaeology.

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Ceramics from Malekula, northern Vanuatu: The two ends of a potential 3000-year sequence

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Introduction

This paper presents results from recent archaeological investigations carried out on the island of Malekula, northern Vanuatu. The ceramic remains indicate that the island was settled some 3000 years ago during the expansion of the Lapita Cultural Complex. Although later transformations are hinted at from the analysis of several surface collections, there is as yet insufficient data to define the post-Lapita ceramic sequence (ca. 2500–1000 BP) in any detail. The recent research results did, however, provide adequate data for a preliminary definition of the ceramics associated with at least the last 500 years. Vessels are characterised by tubular pots with conical bases that are either plain or decorated. Similar vessel forms and/or decoration are found from the north to the south and from the coast to the centre of the island. This ceramic homogeneity also extends across a number of islands of northern Vanuatu suggesting regular contact and interaction. There appears to be a breakdown in this communicative network during the last few hundred years when ceramics either died out or became island-specific.

This paper reviews results from archaeological work carried out on the northwest of Malekula, Vanuatu, in the mid- to late 1990s. More specifically, it assesses the ceramic remains that were recovered and attempts to situate them in both a chronological and regional context. The research was part of the ANU–Vanuatu National Museum Archaeological Project which began in 1994 and it has also involved extensive excavation further south on the islands of Efate and Erromango (see Bedford 2000; Bedford et al. 1998; Bedford and Spriggs 2000). All field work on Malekula was undertaken in collaboration with Jimmy Sanhanbath, the Vanuatu National Museum field worker for the northwest area of the island.

Malekula, the second largest island in Vanuatu, located in the north of the archipelago, has in the past been more widely known through accounts of the exotic cultural manifestations that were found amongst the island's inhabitants. Dating from the first visits by Europeans, the earliest was James Cook in 1774 who described the Malelukans in somewhat less than flattering terms (Beaglehole 1969:462), they began to gain some level of notoriety and from then on have inspired European imaginations of the exotic other. Included amongst the cultural milieu that attracted and excited observers were social practices such as head binding, a local variant of mummification, cannibalism and ritualised homosexuality.

It was no doubt this exoticism that inspired and attracted both early anthropological research (Deacon 1934; Layard 1928, 1942; Speiser 1996) and a number of early 'adventurers' to visit the island. Some of these visits resulted in the publication of popular accounts with suitably sensationalist titles. Included amongst these were classic works such as *Cannibal Land* (Johnson 1922), *I Married Adventure* (Johnson 1940) and *Savage Civilisation* (Harrisson 1937). Malekulans also featured in the pages of the *National Geographic* (Muller 1972).

Previous archaeological research

The sustained anthropological fascination with Malekula and Malekulans has not been matched by archaeological interest despite early tentative investigations carried out by the Swiss ethnologist Felix Speiser in the 1910s. Speiser dug a number of test pits at different sites on Malekula in an apparent search for an early 'Palaeolithic culture'. However, the results of the test-pitting were described by the excavator as "disappointing" (Speiser 1996:83–86). It was not for another 50 years or so that further archaeological research was again carried out on Malekula. The drought was broken by Mary and Richard Shutler who briefly visited the island in the 1960s during which time they made extensive surface collections of ceramics throughout the north. Although no excavations were undertaken and little of the collected ceramics have been published in detail (Shutler 1970; Shutler and Shutler 1975), a type collection was sent to a number of museums in the Pacific and further afield.

Further archaeological research was undertaken on the island in the 1960s by Caroline Leaney who was encouraged by the Shutlers and partly funded by the Bishop Museum. Leaney, who had a degree in archaeology from Cambridge, was stationed on Malekula with her husband who was the British District Agent on the island. She carried out a series of surveys and excavated test pits in cave sites throughout the island. The test pits returned limited results (Leaney 1965), but what was clear from all of these surveys (and something regularly mentioned in early historical accounts relating to Malekula) was the presence of pottery on the ground surface over virtually all of the island.

This was not unexpected as ceramics continued in use on the island, at least in the south, until European contact. There, whole pots or broken pieces of pot known as *Naamboi* were often used in association with various ceremonial activities (Deacon 1934; Layard 1928). Its mythic status has been enhanced by the fact that there are no historic records or oral traditions that refer to it actually being made on the island. In the north of Malekula there are no oral traditions at all associated with pottery use or manufacture. It is generally associated there with biblical events (*Graon pot blong Noah*). In the south, oral traditions attribute pottery to mythical individuals known as the *Ambit* (Layard 1928:210).

Recent research

Apart from the fact that Malekula as a whole remained a virtual archaeological blank, the northwest of the island was targeted for research for several reasons. The high rates of tectonic uplift in this area of the island (Taylor et al. 1980:5369) greatly enhanced the prospects of site preservation. The northwest coastal landscape comprises a series of uplifted coral terraces riddled with caves and shelters which provide an ideal setting in which to begin to define both the timing and nature of the initial settlement and later cultural transformations that have occurred. The largely unknown ceramic sequence on Malekula had potentially spanned a period of 3000 years. Another research objective was the testing for any evidence of pre-Lapita settlement on the island. The proposition of pre-Lapita settlement in Vanuatu, which had been mooted some 30 years before (Garanger 1972), has been more recently rekindled by a number of archaeologists (Galipaud 1996a, 1996b; Gorecki 1992; Gosden et al. 1989). Some of the more recent enthusiasm for this argument was generated by the confirmation of Pleistocene settlement further west in the Solomons (Wickler and Spriggs 1988). In addition, some archaeologists claim alleged parallels between Garanger's Mangaasi-style pottery from Vanuatu and ceramics from New Guinea which have been controversially dated to ca. 5000 BP (Gorecki et al. 1991; Swadling et al. 1989). The large high islands of northern Vanuatu were identified as being the most likely locations for providing some clarification of this question (Gorecki 1992:44).

During the field work of 1995–1997 surveys and excavations were concentrated along a 10 km stretch of the northwest coast, along with forays some kilometres into the interior (Fig. 1). A number of perennial rivers drain from the interior and are associated with sheltered bays. These would have been prime areas for settlement, and Malo with its numerous Lapita sites can be clearly seen from the northwest of Malekula. Some 50 caves/shelters or overhangs were recorded and subsequently 15 caves and four open sites were excavated in different locations along the coast and further inland. The stratigraphy of the caves was relatively consistent, representing intermittent occupation with ash lenses from cooking fires, fire-cracked stone, shellfish, bone and relatively sparse artefactual material.

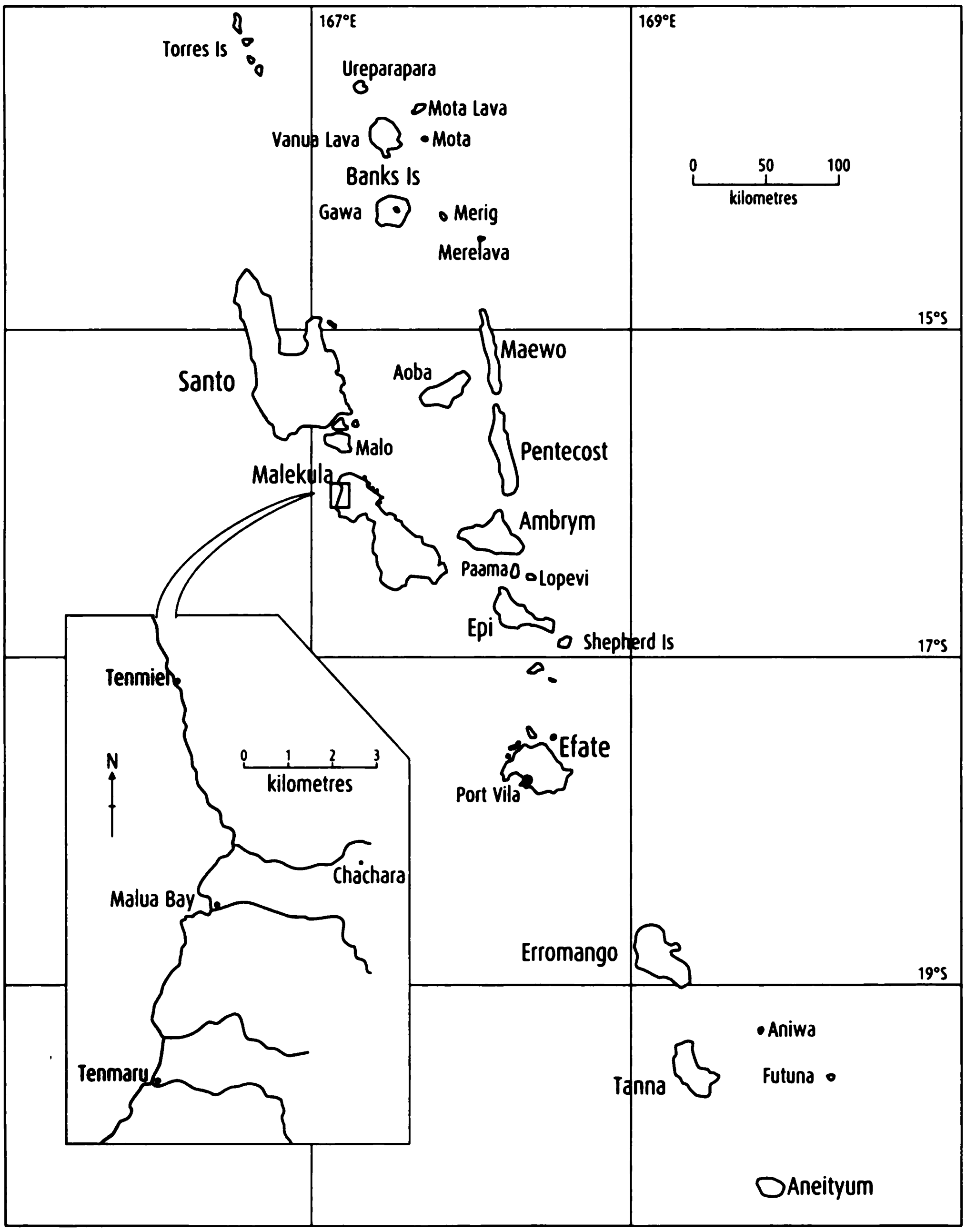

Fig. 1. Vanuatu and northwest Malekula (inset).

Early ceramics: Malua ware ca. 2700–2500 BP

At all caves, ceramics were found at the base of the cultural stratigraphy. But it was only from the caves near the coast, and only then from the lowest cultural deposits, that a thin-walled calcareous-tempered plain ware was recovered. The pots were globular bodied with out-curving or direct rims, some of which had notching on the lip (Fig. 2b–d). The earliest date from the cave sites was ca. 2500 BP. These ceramics were characterised in further detail at the open site of Malua Bay, the site after which this distinctive ware has been named. This site provided evidence of first arrival/settlement in this area of the northwest, some 12 m asl within the garden of the local school (Fig. 3). A total of 14 sq m was excavated to determine the extent and stratigraphy of the site and to collect a sample of the cultural material.

The recovered ceramics included hundreds of calcareous-tempered sherds from the same globular pots that had been excavated from the lowest cultural levels of the coastal caves. Petrographic analysis undertaken by Professor William Dickinson confirmed the sherds as being indigenous to Malekula (Dickinson 1997). Also amongst the somewhat invariant assemblage was a single dentate-stamped sherd (Fig. 2a). Paired shell and charcoal samples from the lowest level of the site returned calibrated dates of ca. 2700 BP. The site would seem to postdate initial Lapita arrival in Vanuatu which has been dated to around 3000–2900 BP on other islands. It seems almost certain that sites which date to this period remain to be identified on Malekula. Certainly dentate-stamping as a decorative technique was by this date (2700 BP) very rare. Other recovered artefactual material included part of a *Conus* sp. shell ring and bead, a shell ear pendant, a small argillite adze and a possible coral net sinker. Frequent pig, sea turtle, bird (including both *Gallus gallus* and local species, one of which has been identified as a new species of parrot, now extinct [Dave Steadman pers. comm.]), fruit bat and rat bone were recovered, along with concentrated shellfish remains. Small quantities of fish bone were also recorded, all of which were identified as inshore reef species (Leach et al. 1998).

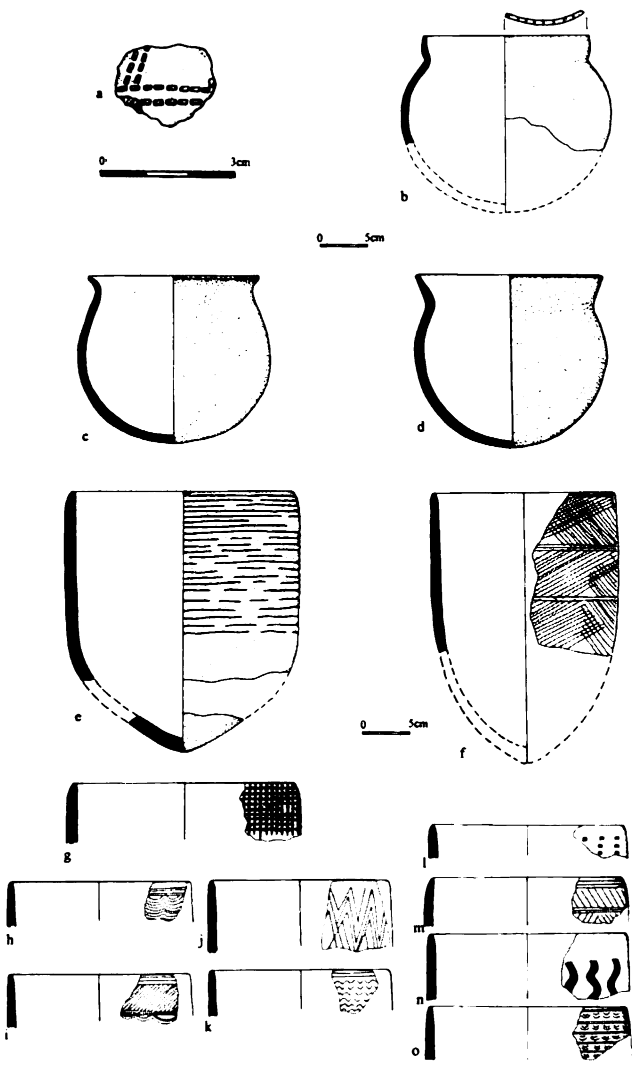

Fig. 2. Decoration and vessel forms from Malekula. Dentate stamped (a), Malua ware vessel forms (b–d), Chachara ware (e), decorated Chachara ware (f–o).

Malua Bay appears to represent a short-term occupation in a prime area for settlement, with a fresh water source, a sheltered bay with good canoe access and abundant food resources (Frimigacci 1980). After occupying the site for a short period, it appears that people moved on to other pristine locations. The stratigraphy of the site indicated a period of less intensive use or even abandonment after this initial occupation, a scenario that was also seen in the stratigraphy of some of the cave sites. A possible reason

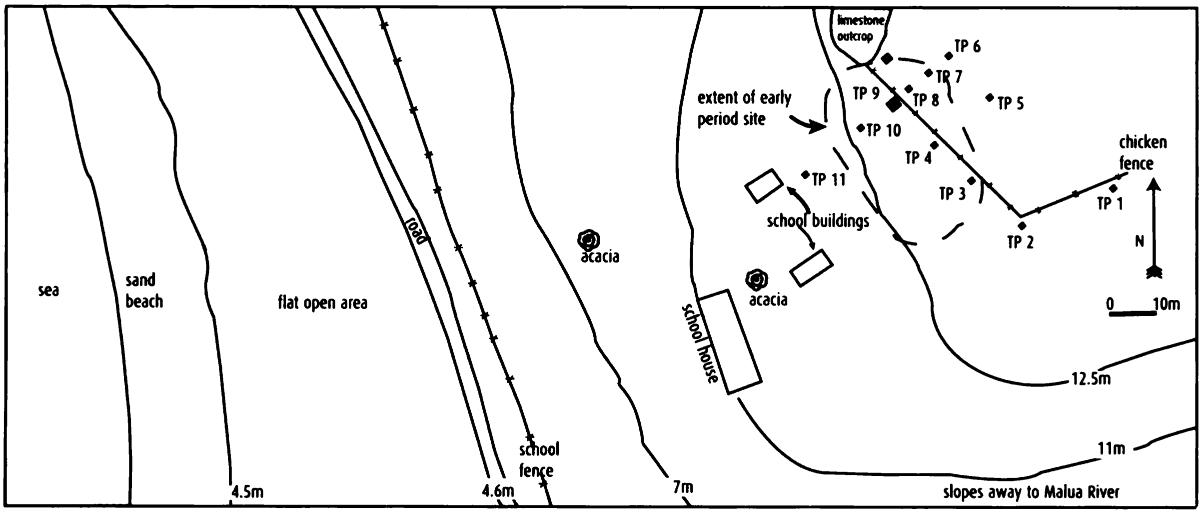

Fig. 3. Location of the Malua Bay site in northwest Malekula.

for this might have been environmental, in that this area is located on the drier leeward side of the island and colonisation could have had a more dramatic effect on the environment than might have been the case in wetter areas. Poor forest regrowth after initial clearance might also be expected along with more marginal agricultural production given the low rainfall regime. Historically the area has always had a significantly less concentrated population than on the east side of the island.

Late ceramics: Chachara ware to Naamboi ca. 600 BP to contact

The archaeological evidence suggests that the northwest area was again more intensively occupied around 1000 BP by people who made quite different ceramics. There is also evidence that more marginal areas, such as the mountainous interior, began to be more intensively settled as populations increased. In the upper layers of the coastal caves and all layers of the inland caves a quite different style of pottery was recovered and it is these ceramics that are also generally found on the ground surface. These ceramics are also found in association with the frequently recorded *nasara* or ceremonial structures and adjacent village sites that are found throughout Malekula. Although *nasara* can vary slightly in form, in the northwest area they generally consist of rectangular stone platforms with upright stones set within them. *Nasara* are associated with various grade-taking ceremonies which are an integral component of the political and social structure that exists in the north and central north of Vanuatu. In this region the chiefly system is based on a hierarchy of grades which is achieved and consolidated through ritual and economic tests. This contrasts significantly with the chiefly system of the centre and south of Vanuatu which is based on title rather than achievement (Bonnemaison 1996:200). Structural remains similar to *nasara* are not found in the centre or south of Vanuatu and by about 1200 BP ceramics have also disappeared from the cultural repertoire of the islands in the centre and south.

The earliest date thus far associated with these *nasara* and the recovered pottery is a radiocarbon determination of ca. 550 BP from the site of Chachara, which is located 2.5 km inland and some 250 m asl. These sites and the political structures associated with them would thus seem to have a pedigree of at least 500 years on Malekula, as do the associated ceramics. These ceramics (Chachara ware) are characterised by coil-made 'bullet-shaped' pots. The vessels include both plain and decorated forms, and are most likely associated with cooking and ceremonial activities respectively. The plain vessels are significantly more common in the excavated sites and surface collections and do not have smoothed exteriors. They thus have a ribbed surface (Fig. 2e) and in some cases a scaled appearance due to further modelling of the clay. The decorated vessels are slightly smaller in rim diameter and have smoothed exteriors, facilitating decoration comprised predominantly of incision, with lesser cases of fingernail impression and punctation (Fig. 2f–o). No applied relief, perforations or handles were recorded.

By combining the excavated materials and other surface-collected ceramics from throughout Malekula we get an indication that some form of cultural homogeneity existed on the island for at least the last 500 years until shortly before European contact. Similar vessel forms and/or decorative motifs dating to this period are found throughout Malekula and at least 21 motifs were recorded from more than one location on Malekula (see Bedford 2000 for more detail). Petrographic analysis again confirmed the Malekulan origin of these late ceramics, although unlike Malua ware none of the late sherds were calcareous-tempered. Sherds from similar pot forms in different areas of Malekula were examined by Dickinson who summed up the mineral inclusions as a "petrographic morass", suggesting that the pots were being made throughout the island and were not restricted to a small number of manufacturing centres (Dickinson 1999a).

It must be emphasised that amongst the recently collected surface sherds and those held in the Vanuatu Cultural Centre there is a multitude of motifs associated with quite different vessel forms that were not recovered during the recent excavations. These remains highlight the fact that there is a lot more to the Malekulan ceramic sequence than has yet been revealed archaeologically. The remains hint at a potentially quite lengthy ceramic sequence. The question of continuity between the early Malua wares and the much later Chachara wares is as yet far from determined.

Sherds from other northern islands (apart from Santo and the Banks Islands) are few and far between due to a general lack of archaeological research, but the valuable work of the Vanuatu Cultural and Historic Sites Survey in collecting surface sherds during surveys has provided some useful information. This, along with the archaeological excavations and survey work of Hedrick (n.d.) on Malo and Galipaud (1996c, 1998) on Malo and Santo, has enabled further and more detailed inter-island comparisons to be carried out. Similar sherds (Chachara ware) have been recovered from the islands of Santo, Malo, Pentecost, Ambae and Maewo — a region that has previously been described as a kind of "Oceanic Mediterranean" (Bonnemaison 1996:208). The ceramics clearly demonstrate some homogeneity of vessel form and decoration during the latter part of the sequence. The same bullet-shaped ribbed pots are found on all of these islands, along with a number of shared motifs (thus far eight) which are a clear indication that regular contact and interaction occurred amongst the inhabitants. These connections were initially hinted at by Hedrick (n.d.) who recognised the similarity of a single motif from Norsup (Malekula) with material recovered from Malo. Galipaud (1996a:123), in a more wide-ranging survey further highlighted similar manufacturing techniques and decoration in ceramics from the islands of Malekula, Santo, Pentecost and Ambae.

There is a breakdown in the above pattern of ceramic similarity during the last few hundred years when new vessel forms and/or decoration begin to appear on a number of the above islands, or ceramic production ceased altogether. This disruption is characterised on Malekula by the appearance of distinctive thick-walled pots and cylinders known as *Naamboi*, which have to date not been recorded on other islands. It is these vessels that signal the last phase of ceramic production on Malekula.

The *Naamboi* are generally tubular in form with a conical base, hence attracting the generic term 'bullet pots'. Large and small versions have been recorded along with a multitude of decorative motifs (see Bedford 2000; Cayrol 1992; Layard 1928). The vessel form clearly appears, at least on morphological grounds, to have developed from the earlier decorated bullet-shaped pots (Chachara ware) found throughout Malekula. The walls and the base of the *Naamboi* show a dramatic increase in thickness compared with the earlier vessels and their cumbersome size and form render them less suitable for cooking purposes. The absence of any charred residues on the internal surfaces, or blackening of the exteriors of these pots, would seem to further support this argument.

The multiple factors that led to the decline and finally the complete loss of pottery-making on the island seem to coincide with a shrinking sphere of interaction with other islands in the north and the development of increasing territoriality across Malekula itself. Sustained contact with Europeans from the early 19th century, with introduced diseases followed by labour recruitment drives, would have had dramatic disruptive effects on the local social and cultural systems. From at least the mid-19th century significant population decline was noted throughout Vanuatu (Harrisson 1937; McArthur 1967; Spriggs 1997:255–260).

Although the causes leading to the collapse of ceramic production on the island remain elusive, it seems likely that one effect was to elevate the increasingly rare surviving vessels to a sacred status. The ethnographic record relating to ceramic usage, collected by the anthropologists Deacon (1934) and Layard (1928) during the early 20th century, clearly postdated this transformational phase which ultimately led to the elevation even of pieces of pots to *tabu* status.

Two villages on Santo were the only places where pottery manufacture was still being carried out in Vanuatu into the 20th century. There are detailed ethnographic accounts of long-established trade routes existing amongst the northern islands of Vanuatu including one of pots coming to Malekula from Santo (Huffman 1996). The archaeological evidence for the presence of Santo pots on Malekula is thus far lacking although this is most likely due to a lack of research in particular areas. A single surface-collected sherd from Tenmaru village on the northwest coast is very similar to the late Santo material in both form and decoration. The results of a petrographic analysis carried out by Dickinson indicate a potential Santo origin (Dickinson 1999b).

Discussion and summary

What explanations, then, might be suggested for the appearance in the north of Vanuatu of a very distinctive ceramic style sometime after 1000 BP which at this stage of research appears to have no apparent antecedents? The ceramics also appear to coincide with divergence in the nature of the political structures of the north from those from the centre and south of Vanuatu.

This issue has recently been speculated upon by Roger Green (Green 1999). He combined archaeological, linguistic and biological evidence to suggest that influence from Near Oceania in the form of sustained contact or even migrations of non-Austronesian speaking groups might well have contributed to substantial change in this part of Remote Oceania in the last 1000 years. It seems quite possible that such influence was a major factor. Certainly, oral traditions in the north of Vanuatu talk of the grade-taking ceremonies or *nimanggi* as being a recent innovation (Tryon pers. comm.). This recent research seems to confirm that substantial social and political change has occurred within the last 1000 years. However, without further archaeological research both in Vanuatu and in areas to the west specifically targeting this period, any finer explanation of these processes will remain largely speculative. But certainly one could not agree more with the sentiment recently expressed to me by Roger Green regarding northern Vanuatu: "it is a gold mine for the later [prehistoric] periods".

Although results gleaned from the excavations and the analysis of surface collections goes some way to filling the archaeological blank that was Malekula, substantial gaps in the archaeological record remain and in many respects this research can be regarded as preliminary. Now more fully understood are the two ends of the ceramic sequence on Malekula. One is specifically related to the timing and associated ceramic remains of the initial settlement of the northwest of Malekula which can now be confirmed as lying firmly within the expansion into Remote Oceania by members of the Lapita Cultural Complex. It was not possible to define the central portion of the ceramic sequence due to two interrelated factors, namely the sparse remains that were recovered from most of the caves and the likelihood that the northwest area of Malekula experienced a period of abandonment or less intensive settlement after initial colonisation.

Despite the apparent gap in the ceramic record postdating the initial settlement phase there is enough variety in the decorative motifs and the different vessel forms found amongst the surface collected sherds to indicate that manufacture and use of ceramics did continue at least in some areas of Malekula for a considerable period. It is too early to say whether the ceramic sequence is continuous through to the later traditions evidenced in the archaeological record. But it does seem possible that there was, in fact, a lengthy sequence, albeit unevenly distributed, potentially parallelling the longevity of the central Vanuatu sequence which lasted until 1200 BP. Definition of the post-Lapita ceramic sequence on Malekula and other islands of northern Vanuatu remains a major research requirement.

The last phase of ceramic production on Malekula is characterised by the bullet-shaped, coil-made pots which appear in the sequence no earlier and possibly sometime later than 1000 BP, in association with ceremonial structures. These in turn might indicate the development or arrival of new political and social structures. Similar vessel forms and design motifs have been identified across Malekula and other islands of northern Vanuatu indicating some form of cultural homogeneity. This appeared to break up just prior to, or around the time of, sustained European contact. The final phase and demise of ceramics on Malekula recorded in the ethnographic period is associated with *Naamboi* which appear to have evolved from earlier forms (Chachara ware) found across Malekula. *Naamboi* can now be confirmed as being restricted to the very end of a lengthy ceramic sequence, rather than being seen as the result of some much more ancient cultural influence as has been suggested by several researchers (Cayrol 1992; Galipaud 1996a:123).

The archaeology of the last 1000 years in Vanuatu, a period that has witnessed significant cultural change, remains one of the least well-defined periods — as is the case throughout much of the southwest Pacific region. However, there is a high likelihood that this period will prove to be one of the most profitable in terms of detailing episodes of human interaction and adaptation that have substantially shaped the contemporary human biological and cultural landscape.

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The Strandlooper concept and economic naivety

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Introduction

The subsistence economy of colonising groups in the Pacific has been the subject of considerable debate. The Strandlooper concept, developed in southern Africa, was invoked by Groube (1971:312) to account for aspects of the archaeological evidence from early Lapita sites in Tonga and Fiji and, in particular, an apparent early emphasis on shellfish exploitation and coastal settlement. Groube suggested that Lapita potters might have been "oceanic strandloopers", living primarily on marine resources, who expanded ahead of colonisation by agriculturalists. He proposed "that the Lapita potters, initially at least, had a restricted maritime/lagoonal economy and that either the development or introduction of a more viable horticultural economy enabled them to expand and survive in Fiji and Tonga to eventually colonise the remainder of the Pacific".

Clark and Terrell (1978:309–310) picked up the idea and incorporated it as one of four possible ways to model what they described as "the Lapita problem". Exactly what was meant by a "restricted maritime/lagoonal economy" was never made entirely clear by Groube. The southern African strandloopers were coastal foragers who scavenged marine mammals as well as fishing and shell fishing. However, Groube developed his hypothesis during his field work in Tonga in response to a profusion of large dense shell middens with little apparent evidence of mammal, reptile or bird remains. Accordingly, his restricted maritime/lagoonal economy has sometimes been interpreted by others as if it meant largely or entirely fishing and shell fishing.

The Strandlooper model was questioned by Green (1979:37, 1982:13–14) and Kirch (1979:297–298) on a number of grounds. It has been officially declared dead by Kirch in his recent writings on Lapita colonisation (Kirch 1997:194, 2000:109). He states that it has been falsified by evidence of permanent settlements, food peelers, domestic animal bones and direct botanical remains, as well as by linguistic reconstructions. He also argues that "would-be colonists usually were equipped to establish permanent settlements, which meant that they *had* to transport and transplant their crop plants and domestic animals" (Kirch 2000:59 [emphasis added]).

Yet aspects of Groube's hypothesis have shown a considerable reluctance to die, particularly in discussions of the Lapita colonisation of the central Pacific and the later colonisation of East Polynesia.

Best (1984:650–653) suggested a lagoon/reef-dominated adaptation for the early eastern Lapita colonists of the Lau Islands. More recently, Burley found: "The immediate impression of Ha`apai archaeofaunas is sympathetic to Best's argument for a heavy reliance on natural resources. We, too, have yet to find indisputable evidence for pig or dog" (Burley 1999:196). In a fuller discussion of the Lapita settlement of Tonga (Burley 1998:354–355) he concluded as follows: "At least initially, it seems likely that agricultural activities were of secondary importance. As for domesticated animals other than the chicken, there is only marginal evidence for pig and dog in excavated faunal collections" (Burley 1998:355).

Anderson, in favouring a late settlement model for East Polynesia, proposed that: "predation took early precedence over horticultural expansion and that since preferred faunal resources were depleted fairly easily and quickly, there was an incentive for some people to move on in search of new reserves quite soon after colonization, instead of remaining to invest more energy in horticultural expansion" (Anderson 1996:367).

He noted that this differs from Groube's hypothesis in not proposing a later arrival of horticulture, but apparently assigns a much reduced role to horticulture during initial settlement. Although he drew a contrast between a "familiar set of large, well-watered tropical islands" encountered by Lapita colonists in Western Polynesia and the more variable environments of East Polynesia (Anderson 1996:364), he also noted the archaeological evidence of a relatively greater hunting and foraging effort in the earliest West Polynesian sites (Anderson 1996:367–368).

Thus it appears that in both the central and eastern Pacific, questions remain about the nature of the subsistence economy of colonising populations, and it is worth asking whether the same subsistence strategies were appropriate or indeed viable everywhere from the Bismarck Archipelago to the Marquesas and Rapanui.

Ironically, the best archaeological evidence to date for the Lapita subsistence economy described by Kirch is from Near Oceania, where human survival by hunting and gathering had been possible for many thousands of years. It is in the Bismarck Archipelago that direct evidence of economic plants has been found (Kirch 1997:206–207), although the starchy root crops are still attested only by linguistic reconstructions.

The faunal remains from the earliest sites in the archipelagos of Remote Oceania *are* different, raising questions about the first few decades or generations of human settlement on these islands. Probably no-one would deny that Kirch's "transported landscapes" (Kirch 2000:109) eventually reached almost all settled parts of Oceania, but it has not yet been demonstrated by archaeological evidence that they arrived everywhere with the first canoes rather than progressively over a longer period.

To understand more about successful human colonisation of Oceanic islands, we need good archaeological sites and high-quality faunal analyses. These have been far fewer than is desirable. For example, Butler (1988:99), in a review of Lapita fishing, found that fish remains were reported from only 27 of 42 sites excavated before 1984 and only five of these yielded fish bone NISP (number of identified specimens) greater than 30. This was not a good basis for understanding Lapita fishing. Similarly, firm identifications of pig, dog and chicken are far rarer than one would like (Nagaoka 1988:122). Turtles are sometimes cited as an important food resource for initial colonists on oceanic islands but, again, firm evidence is rare. Nagaoka (1988:122–123) reported MNI of 42/54 from four Lapita sites in Fiji and NISP of 1421 from five other sites, including 1349 from one site on Tikopia. As she cautioned, the nature of the remains means that turtle can be over-represented by NISP. In East Polynesia, Leach et al. (1984:185) reported an MNI of 26 from Fa'ahia.

In trying to develop testable hypotheses, we need a reasonable level of understanding of human nutritional requirements. It is also possible now to overcome to some extent the "near invisibility of agricultural production in the archaeological record" (Burley 1999:196) and gain a clear understanding of the proportions of plant foods in the diets of actual people, using stable isotope analyses of human tissue. We draw on these last two lines of approach to reconsider the diet of early colonists.

Some aspects of human diet

The key ingredients in human diet are protein, fat, carbohydrates, minerals, vitamins and water. Protein is required because it is one of the best sources of certain essential amino acids. Fat is needed to provide three essential fatty acids (Crawford 1992). Two of these (linoleic and linolenic, also called Omega 3 and Omega 6) must be taken in as food, enabling the third, which occurs more rarely in foods, to be synthesised. The other principal requirement (other than vitamins, minerals and water) is a source of caloric energy. This can come from protein, carbohydrate or fat. There are two essential points to note here:

1. Protein sources of food can contribute, at the most, about 30 per cent of energy needs (Draper 1977:311); protein normally contributes about 10–15 per cent (Noli and Avery 1988:396). If too much energy is obtained from protein, azotaemia (excess nitrogen) results. This causes a rise in plasma ammonia, which can become fatal (Noli and Avery 1988:397).
2. Contrary to popular belief, large amounts of carbohydrate such as that which can be obtained from starchy plants are not essential: the necessary caloric energy can also be obtained from fat. Some carbohydrate is essential for the human brain; this can be obtained from a form of animal protein, namely liver, which contains an animal carbohydrate known as glycogen. There is also some carbohydrate in shellfish. Thus it is possible for humans to live entirely on lean meat and fat without any plant foods. The Inuit are the well-known example of this (Draper 1977:315).

The diet of Pacific islanders (including New Zealand Maori), then, could not consist mainly of protein; significant sources of carbohydrate and / or fat were needed.

A New Zealand example

We are currently examining the subsistence economy of pre-European Maori who lived on the shores of Cook Strait in central New Zealand. This is an area close to the southern limits of Polynesian horticulture, linking the more fully horticultural north and the completely hunter-gatherer south of the country.

It has been customary to consider that Cook Strait was a land of plenty for the first Maori settlers — largely on the basis of the Wairau Bar site, long regarded as a hunters' paradise (Anderson 1989:123–125; Duff 1942, 1956). The Palliser Bay archaeological project conjured up a paradise of another kind — one in which small-river mouth villages flourished beside extensive gardens of kumara (sweet potato, *Ipomoea batatas*) (Leach and Leach 1979; Leach 1981). At the other end of the sequence, the first European visitors to Queen Charlotte Sound in the 1770s painted a bleak picture of people who lived entirely on fern root and fish and were in a constant state of intergroup tension and warfare (Salmond 1991:253–259).

Our research on marine exploitation has shown that Cook Strait Maori, from first settlement till the 19th century, had access to abundant supplies of fish and shellfish. Although intensive gathering of shellfish from localised areas of rocky shore could have a measurable effect, as happened at Black Rocks in Palliser Bay (Anderson 1979), the total shellfish resource on this rocky coast was virtually inexhaustible. Analyses of the fish catch from a number of sites in the Cook Strait area attest to successful fishing over a long period (Horwood et al. 1998; Leach et al. 1997). Fish and shellfish are a significant component of both so-called moa-hunting sites (e.g. Davidson et al. n.d.) and relatively moa-less early sites (e.g. B.F. Leach 1979). Protein, then, was never a problem for Cook Strait Maori, even if they had less variety of protein in the 18th century than they had earlier. For them, as for Maori elsewhere, the problem was obtaining enough caloric energy from sources other than protein.

Although Cook Strait has been considered marginal for Polynesian horticulture, there is archaeological evidence of gardening. In Palliser Bay, most of the gardens were shown to be early and it was argued that climatic fluctuations, particularly the onset of the so-called Little Ice Age, had a serious effect on the ability of the inhabitants to continue gardening (H.M. Leach 1979a, 1979b). Various gathered plant foods may have been significant alternative sources of carbohydrate, particularly the roots of the bracken fern (*Pteridium esculentum* var. *aquilinum*) and perhaps also the kernels of the karaka tree (*Corynocarpus laevigatus*) (Colenso 1880:20–26).

The first settlers in Cook Strait, as elsewhere in New Zealand, encountered numerous sea mammals (Smith 1985, 1989), particularly fur seals, which were an excellent source of fat. By the end of the prehistoric period, fur seals were much rarer, probably to the point where a seal of any kind was a dietary windfall, rather than a reliable source of energy. Exactly when the effects of human exploitation of fur seals began to be felt in this region is unclear, because of the relative lack of dated sites of intermediate or late age, but it is possible that sustained cropping at an early period rapidly reduced the population. Thus energy from fat also became harder to obtain and much less reliable.

We are led to conclude that the Cook Strait area was, relatively speaking, indeed a land of plenty for its first Maori settlers. But this was due to the availability of reasonable amounts of both cultivated plant food and fat, rather than the superabundance of protein supplied by the moa-hunters which, on its own, could not support the human population. It may well have been sea mammals that provided the essential caloric energy for the very first settlers while they established their gardens. People's own actions in over-exploiting sea mammals and climatic factors beyond their control combined to make it increasingly difficult for them to obtain a balanced diet and thus maintain a healthy lifestyle in the area. The arrival of Europeans with new sources of carbohydrate, particularly the potato, and new sources of fat (for example, whale oil) transformed the subsistence economy of Maori in the area and enabled incoming northern tribes to occupy parts of the region that had been largely uninhabited during previous centuries. These chronological changes are depicted in Fig. 1.

Fig. 2 presents a summary view of some of the main constituents of Maori diet in New Zealand as a whole for both early and later people. In the northern regions, there was a real possibility of obtaining a significant amount of caloric energy from cultivated plants at all periods. Those in coastal regions of the far south were probably able to obtain a major amount of caloric energy from fat at all periods. Those around Cook Strait may have enjoyed both initially, but would have been hard pressed during the latter part of the prehistoric period. The contribution of gathered plant foods, particularly bracken fern and cabbage trees (*Cordyline* spp.), is not shown. These may have enabled people to obtain sufficient caloric energy when neither fat nor cultivated plant foods were available in sufficient amounts. The point here is that there were different possible ways that pre-European Maori could meet essential dietary requirements. But to make any real progress on the dietary issues in New Zealand it will be necessary to look far more closely at individual regions and also at the nutritional contributions of a wider variety of foods.

Strandloopers revisited

Returning now to the tropical Pacific, it is abundantly clear that people cannot live satisfactorily on a diet that consists largely or entirely of fish and shellfish. This was not an option for the Marquesans when the breadfruit crop failed (cf. Dye 1990:72); nor was it an option for the first Lapita colonists of Fiji and Tonga or, for that matter, New Caledonia, where shell middens also provide the main evidence of early diet (Sand 1995:107). In its extreme form, a "restricted maritime/lagoonal economy" would not enable colonisers to survive and found viable populations. But was it essential for the first colonists of Oceanic islands to bring with them their starchy root and tree crops? Could they have obtained much of their caloric energy from fat? Sea mammals (in this case dolphins or small whales), land birds such as pigeons, and the young of sea birds are potential sources of fat (as yet we have no information on the fat content of turtles). While such resources lasted, people might be able to survive without domestic animals or a full complement of crops. This indeed is what some of the archaeological evidence from early sites in the central and eastern Pacific appears to suggest.

There does not appear to be a fundamental reason why a complete package of crops and domestic animals had to be introduced by the first settlers of any island to ensure the survival of the colony. Nor is there any reason to assume that exactly the same package was initially introduced to each colony. An absence of pigs and dogs from early sites in the central and eastern Pacific need not imply failure to introduce crops; indeed, the presence of pigs need not imply the presence of crops. It is often argued that surplus crops are needed to feed pigs in the Pacific, but pigs are omnivores, and if people could survive, their pigs should also have been able to survive. At present this is an academic issue, since archaeological evidence of pigs is tantalising rare in early sites in the central and eastern Pacific. It is more likely that some crops were introduced ahead of pigs than the other way round. Eventually, most (if not all) of the gaps were filled. But the transported landscape may be the result of progressive accretions rather than an initial makeover in the style of a modern landscape-gardening professional.

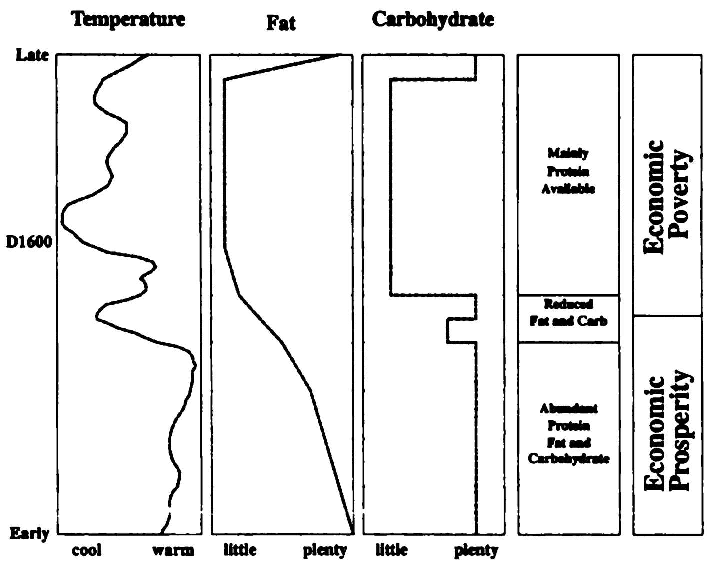

Fig. 1. Environmental and economic changes affecting Maori life in the Cook Strait region.

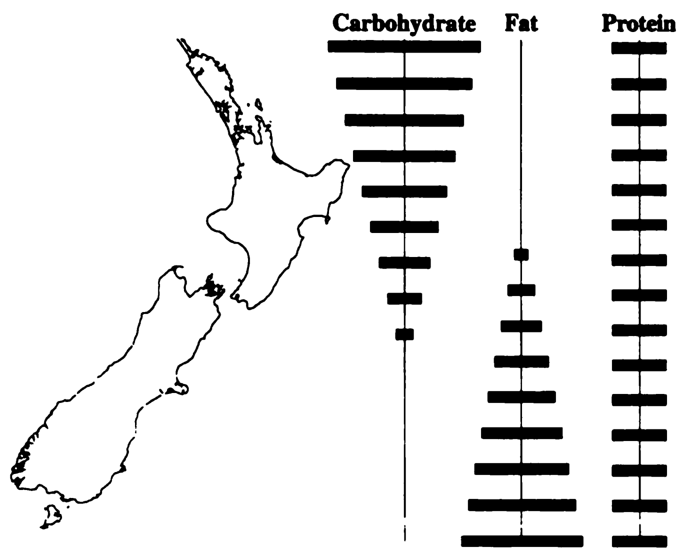

Fig. 2. North-South clines in availability of cultivated foods and sea mammals.

Reconstructed diets

Some progress towards a better understanding of Pacific Island diet can be made through the analysis of stable isotopes in human tissues. The use of ^{13}C and ^{15}N to distinguish the relative amounts of different food sources is reasonably well known. Recently, ^{34}S has proved particularly useful in helping to distinguish terrestrial and marine foods (Leach et al. 1996; 2000). Archaeological bone samples from about 20 Pacific populations have been analysed in this way.

Fig. 3 shows the ^{13}C signatures of samples of human bone collagen from various Pacific Island groups. In this figure, the upper samples appear to have a stronger marine component than the lower ones. However, the use of ^{13}C to separate terrestrial and marine food sources is complicated by the fact that C4 plants (including, for example, sugar cane and pit-pit) group with marine resources. Populations which eat C4 plants directly or eat herbivores which eat C4 plants are pulled towards the marine end of the spectrum. Here we might particularly suspect the two New Caledonian samples along with Motupore and Nebira as being influenced by C4 plants.

The ^{15}N signature has a different problem, in that animals from the inshore reef-flat area group with the land rather than the marine resources. Places where reef flats were heavily exploited are pulled towards the land end of the spectrum. We could suspect that reef-flat foods were important for many of the central samples in Fig. 4.

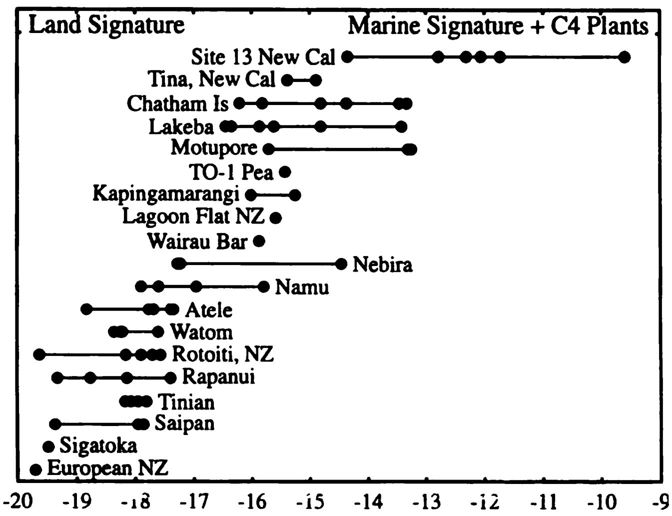

Fig. 3. Values of ^{13}C for various Pacific Island groups.

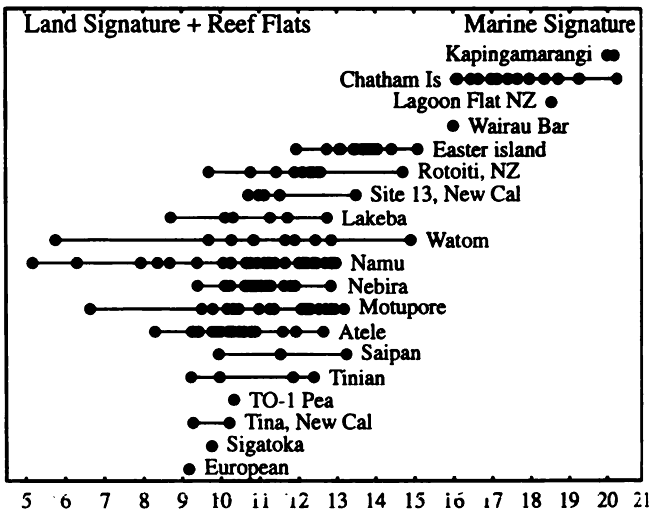

Fig. 4. Values of ^{15}N in various Pacific Island groups.

In Fig. 5, the ^{34}S signatures of samples from 16 of the same Pacific Island groups are shown. Atele, Rapanui and Sigatoka are not included but Natunuku has been added. At the top, towards the extreme marine end of the spectrum, is a mediaeval sample from the Faroe Islands, in the North Sea, where people ate a high proportion of marine foods, particularly pilot whales. This diagram clearly separates out three 'inland' populations and arranges the rest according to their probable degree of dependence on marine resources.

Several points emerge from these diagrams. There is a considerable range within single populations, although the dots do not all represent individuals — some samples have been run several times by different laboratories, particularly those for ^{15}N.

These analyses are only a starting point in reconstructing human diet. Using a stochastic approach, as originally suggested by Minagawa (1992; see also Leach et al. 1996), it is possible to model the proportions of different foods in the diet. Fig. 6 shows the proportions of four major components of the Watom diet, expressed as percentages of food weight and then as percentages of total caloric intake (Leach et al. 2000). The category of 'pigs, etc.' includes terrestrial herbivores such as wallabies. This looks like the sort of Lapita diet (in this case late Lapita) that has long been proposed by both Green and Kirch. In fact, the Reber-Rakival site on Watom produced relatively sparse midden remains (Green and Anson 2000) and it would be hard to argue on strictly archaeological grounds for such an intake of fish and 'pigs, etc.'

It is also possible to model the proportions of caloric energy obtained from protein, fat and carbohydrate for different populations. In Fig. 7 the five New Zealand samples that appeared in Figs. 3–5 are plotted out in this way. It is obvious that these populations were meeting their energy requirements in rather different ways. Such variation within one island group can be the result of regional variation in resources or chronological change, or both.

Essential fatty acids

As pointed out earlier, humans require regular intake of certain essential fatty acids (Davidson et al. 1972), and it is possible that some Pacific populations may have experienced difficulties in obtaining sufficient amounts of these. It is not surprising that fat craving has been widely reported in the Pacific. Pork fat is an excellent source of essential fatty acids, containing 10.35 g/100 g (US Department of

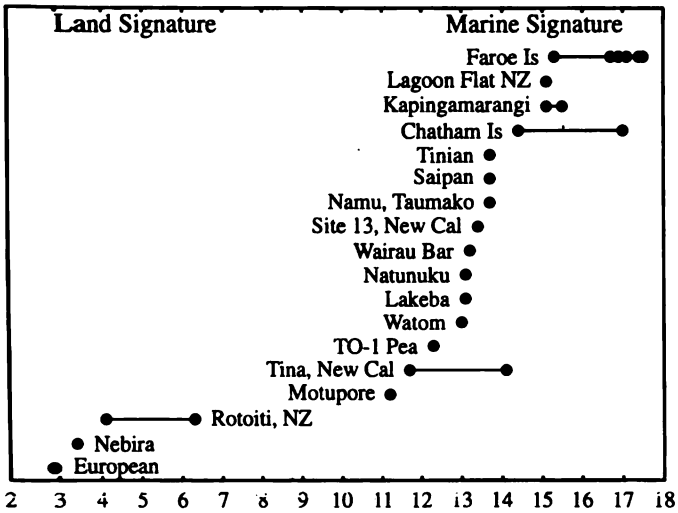

Fig. 5. Values of ^{34}S in various Pacific Island groups and the Faroe Islands.

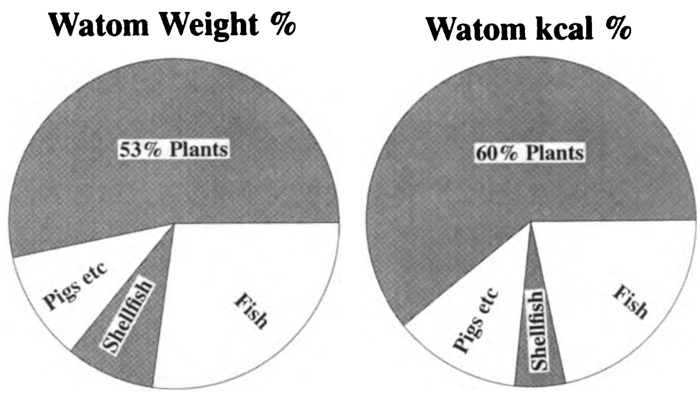

Fig. 6. The proportions of various foods in the diet of people from SAC (Kainapirina) on Watom Island.

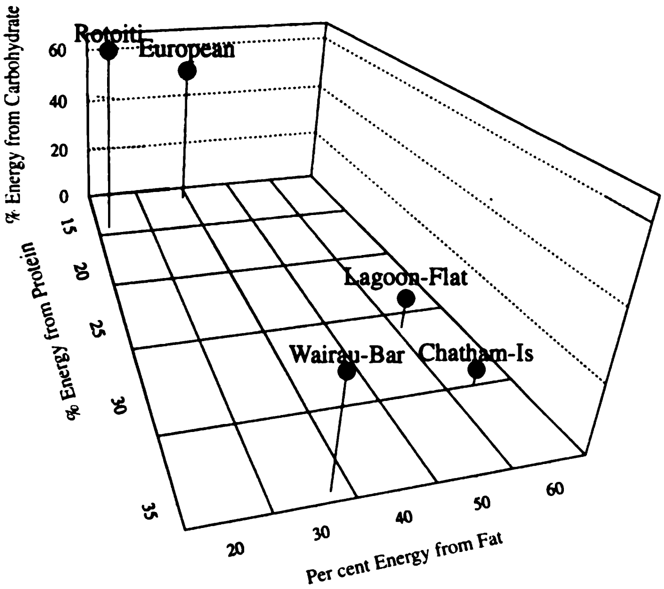

Fig. 7. The per cent energy from protein, fat and carbohydrate in five New Zealand samples.

Agriculture Nutrition Database). Duck fat is even better (13 g/100 g). Human fat normally contains very similar amounts of essential fatty acids to pork, although in vegetarians it is much higher. On the other hand, coconut cream and coconut meat contain around 0.37 g/100 g and tuna flesh a derisory 0.032 g/100 g. One would need to consume huge amounts of coconuts or impossibly large amounts of tuna to obtain sufficient fatty acids from these sources.

In the Cook Strait area in the 18th century one of the few good sources of essential fatty acids may have been human fat. This was an area in which cannibalism was well documented by early European visitors (Salmond 1991:243–244). It may be that people turned to cannibalism not because of a need for protein or primarily for ritual reasons but because of a fat craving and a dire shortage of essential fatty acids. This may also have been a reason for cannibalism and for the importance of pigs in the Marquesas, where the main carbohydrate crop, breadfruit, was unreliable.

Conclusion

The study of human nutritional requirements is a complex field and one that is bedevilled by modern fads and commercial pressures. Many publications promoting supposedly healthy products contain information that is highly misleading if not actually untrue. Relevant information is not always easy to obtain: modern databases do not provide complete nutritional information on extinct fauna or human flesh, for instance. However, we believe it is important for archaeologists to have some understanding in this area so that they can formulate realistic hypotheses about diet and avoid falling into extreme naivety of the sort epitomised by the view that people can live on a diet consisting largely of fish and shellfish. It is equally important not to assume that all Pacific people relied on starchy plant foods for a large proportion of their caloric energy simply because that was the case ethnographically and the words can be reconstructed to this or that proto-language.

Our New Zealand example suggests that people could meet their dietary requirements in different ways. It also illustrates how a combination of human-induced factors (impact on sea mammals) and factors beyond their control (climatic fluctuation) could severely reduce the dietary options available through time.

We suggest that a much better understanding of the subsistence economics of both colonising and later populations will be achieved when rigorous archaeological analyses of faunal and other data are available for many island groups; and dietary reconstructions are informed by a knowledge of human dietary requirements.

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Spatial analysis of fossil phytolith assemblages at an archaeological site in West New Britain, Papua New Guinea

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Introduction

The archaeological site FAO and its surrounding landscape are the focus area for this study. FAO is located on the northeast side of Garua Island close to Mount Baki, a local source of obsidian (Specht et al. 1988), on a coastal ridge overlooking the Bismarck Sea (Fig. 1). This site appears to be typical of other sites located across the island, in that it is situated on the top of a coastal hill. Previous research relating to the site has included the sourcing of obsidian raw material, the establishment of a chronostratigraphy, especially using radiocarbon dating, and the correlation of tephra with those of other sites (Specht et al. 1988). Studies on starch grain composition of the sediments, and use-wear and residue analysis on obsidian artefacts have also been performed (Kealhofer et al. 1999; Specht et al. 1988; Summerhayes et al. 1998; Therin 1994; Therin et al. In press). Three chronological divisions have been defined for the archaeological sequences on Garua Island, these being divided by the tephra of two volcanic eruptions: Period 1 from 5000 to 3600 years ago; Period 2 starting with the Witori (W-K2) eruption at around 3400 to 1100 years ago (incorporating the Lapita period); and Period 2 starting with the Dakataua eruption around 1000 years BP, to the present (Torrence et al. 2000). Site FAO is interpreted as representing a Lapita period, concentrated hill-site settlement (Torrence et al. 1997).

Based on a range of archaeological evidence Torrence et al. (2000) believe that during the late Holocene in West New Britain there is a shift in human subsistence patterns from a highly mobile lifestyle before 3500 years ago (i.e. Period 1) to the more frequent use of coastal hill sites in later periods. This is interpreted as probably reflecting an increase in sedentary behaviour and possibly the use of garden plots and dwellings (Kealhofer et al. 1999; Lentfer et al. In press; Therin et al. In press; Torrence et al. 1996). From Period 2 onwards there is evidence of Lapita pottery in West New Britain. The impact of associated Lapita peoples on Pacific island vegetation in general has been described by Kirch (1997) as one of extreme disturbance, with land clearance on coastal ridges for garden plots. However, to date there has been a lack of evidence for land clearance and gardening during Period 2 on Garua to support the notion of sedentary behaviour. Through the analysis of fossil phytolith assemblages, this study seeks to better understand the past vegetation of the area within which the archaeological site of FAO is located, during Period 2.

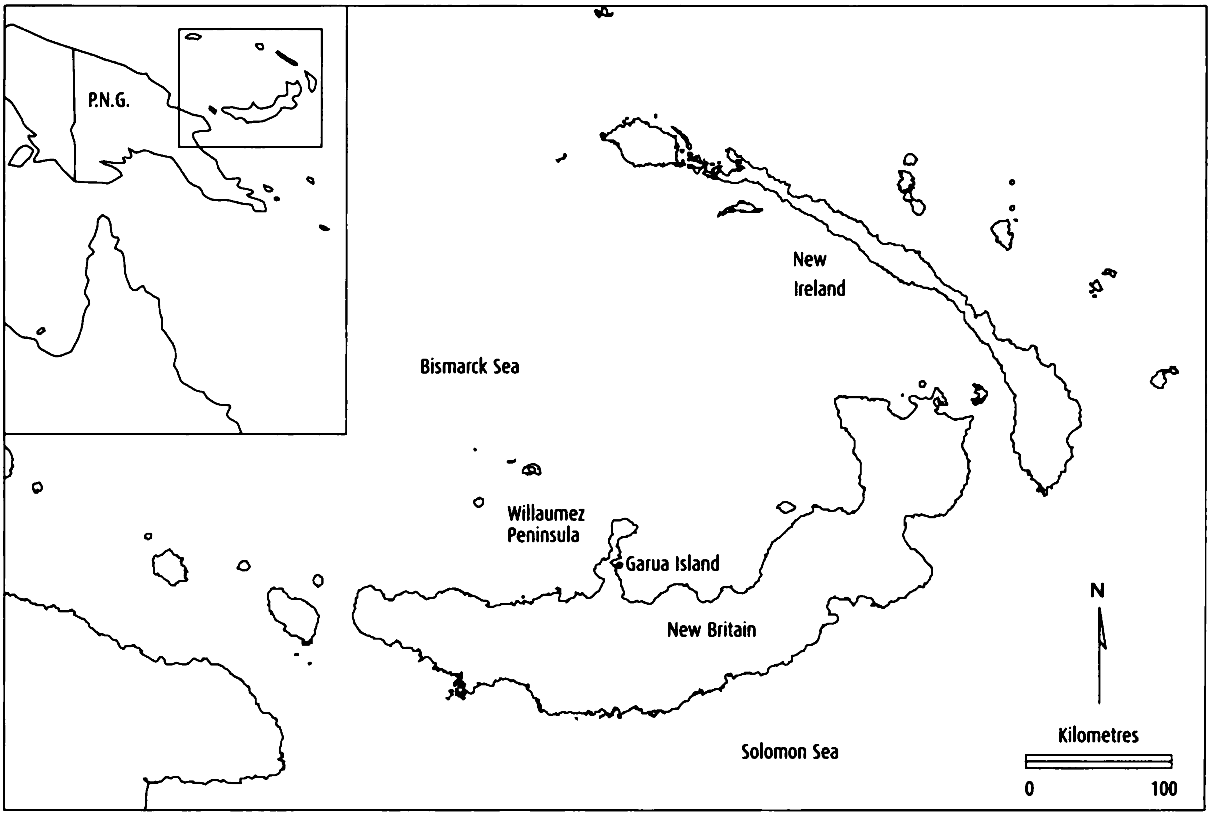


Fig. 1. Map showing the New Britain Province of Papua New Guinea and the location of Garua Island (source: Torrence and Boyd 1996).

Previous research into phytolith assemblages extracted from modern sediments associated with village areas, gardens, regrowth forest and closed forest sites in West New Britain has demonstrated that such environments can be differentiated using multivariate analysis, in particular principal component analysis (Boyd et al. 1998; Lentfer et al. In press). This provides confidence that landscape partitioning or patterning into ecological units such as villages, gardens, regrowth forest and closed forest may be discernible in the fossil phytolith record.

Other additional research incorporating a range of techniques (including X-ray diffraction and the use of a SediGraph 5100 particle size analysis system) has established that there is no evidence for phytolith mobility between the discrete layers of volcanic tephra for the sediments within the study area and that phytolith assemblages within each palaeosol represent the period of subaerial exposure (Parr 1999). Similar conclusions have been made for other volcanic sediments (e.g. Wantanbe et al. 1996). While such studies indicate that for a single site profile changes in vegetation composition can be assessed over time with a degree of confidence, it is potentially problematic to assume that the vegetation depicted in one stratified site is representative of the general area being studied. To determine the nature of vegetation types across a designated area, it is important that samples from a range of locations are assessed. The focus of this study is, therefore, to determine whether there is evidence of patterning in vegetation types for Period 2 at, and around, a typical archaeological site from this period by examining several sub-site sediment sections. Specifically, if some plant diversity is apparent, does it indicate the process of human site clearing?

Material and methods

The West New Britain Province of Papua New Guinea is located around 5 degrees south of the equator in the convergence zone of the Indo-Australian and the Pacific plates (Ollier 1981). It is a wet tropical environment with an annual rainfall of around 4000 to 5000 mm. This area has been periodically exposed to volcanic activity throughout the late Quaternary period (Blake et al. 1974). Garua Island, located off the east coast of the Willaumez Peninsula of West New Britain (Fig. 1), has been occupied by humans for at least 6000 years (Torrence 1994; Torrence et al. 2000). The sedimentary history of the island comprises sequential layers of volcanic tephra and soil development at varying stages of weathering (Boyd et al. 1998). The archaeological study of this area comprises the careful excavation of these sequences. The term 'test pit' (TP) followed by a nominated number is used to described the sampled areas. For example, the site FAO 1000/1000 is referred to as TP 8. Remaining test pit references are shown in Table 1.

During the 1993 and 1997 field seasons, soil samples were collected from the general site area of FAO and outlying test pits (Fig. 2) for phytolith analysis (Torrence and Boyd 1997). With the exception of TP 8, which formed part of a 2 m × 2 m square, all test pits were 1 m × 1 m square with continuous 5

Table 1. Sample numbers and corresponding FAO test pits.

SAMPLE	FAO TEST PITS	SAMPLE	FAO TEST PITS
1a	970/1000	5a	E-1
1b	970/1000	5b	E-1
1c	970/1000	5c	E-1
2a	1000/990	6a	E-10
2b	1000/990	6b	E-10
2c	1000/990	6c	E-10
3a	1000/1020	7a	B-3
3b	1000/1020	7b	B-3
3c	990/970	7c	B-3
4a	990/970	8a	1000/1000
4b	990/970	8b	1000/1000
4c	990/970	8c	1000/1000

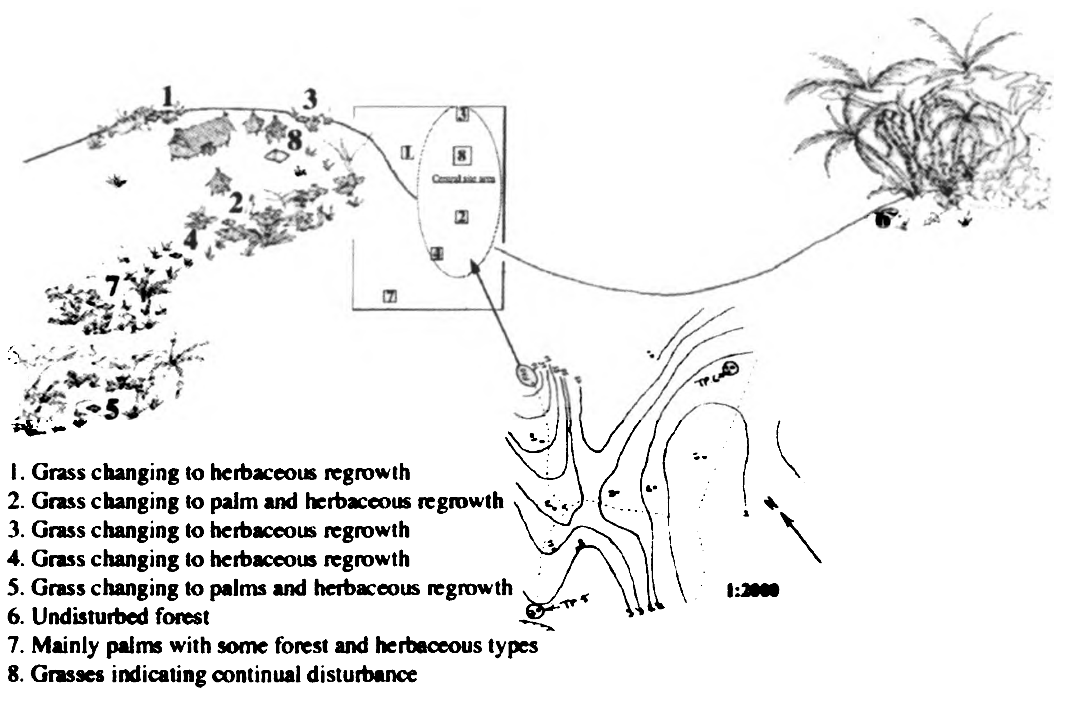


Fig. 2. Schematic drawing of the FAO site and surrounding area, showing approximate test pit positions and their reconstructed associated vegetation types. The oval area depicts the central cleared site area containing test pits TP 2, 3, 4 and 8. To the north and northwest the test pits TP 1, 5 and 7 contain regrowth vegetation while on the southeastern ridge TP 6 contains relatively undisturbed forest.

cm samples removed from the surface down to the Period 1 layer. From each test pit the samples used in this analysis comprise the upper 15 cm of the W-K2 material, which had undergone weathering and soil development, overlying a distinctive and relatively unmodified portion of the W-K2 tephra. The 15 cm of soil development from each test pit represents Period 2, dating from 3400 to 1100 years ago and incorporates sediments from the Lapita period. Although the depth of the samples from the surface varied for each test pit from 50 cm to 100 cm, the distinctive W-K2 tephra provided a uniform temporal base across both the localised site area and the peripheral test pits. Methods used for phytolith extraction from soil samples follow those described in Boyd et al. (1998), Lentfer et al. (1998) and Lentfer et al. (1999). Briefly, these involved the deflocculation of sediments, the digestion of organics and carbonates, and the extraction of phytoliths using heavy liquid flotation (cf. Boyd et al. 1998; Lentfer et al. 1998; Lentfer et al. 1999). Manual counting and phytolith identification were undertaken on an Olympus CH2 microscope, fitted with a polarising filter, at 400× magnification. For counting, 300 phytoliths were recorded and the ratio of diagnostic to undiagnostic phytoliths estimated. Diagnostic phytoliths were identified by making comparisons to previously published morphotypes (see Fig. 3) (Boyd et al. 1998; Lentfer and Boyd 1998; Lentfer et al. In press). The phytolith types described in Fig. 3 were grouped into four broad categories of vegetation and labelled forest, grasses, herbaceous and palms accordingly. Using the statistical package for social sciences (SPSS) software, principal component (PC) analysis was applied to the data for the four vegetation groups and their position plotted in relation to site position.

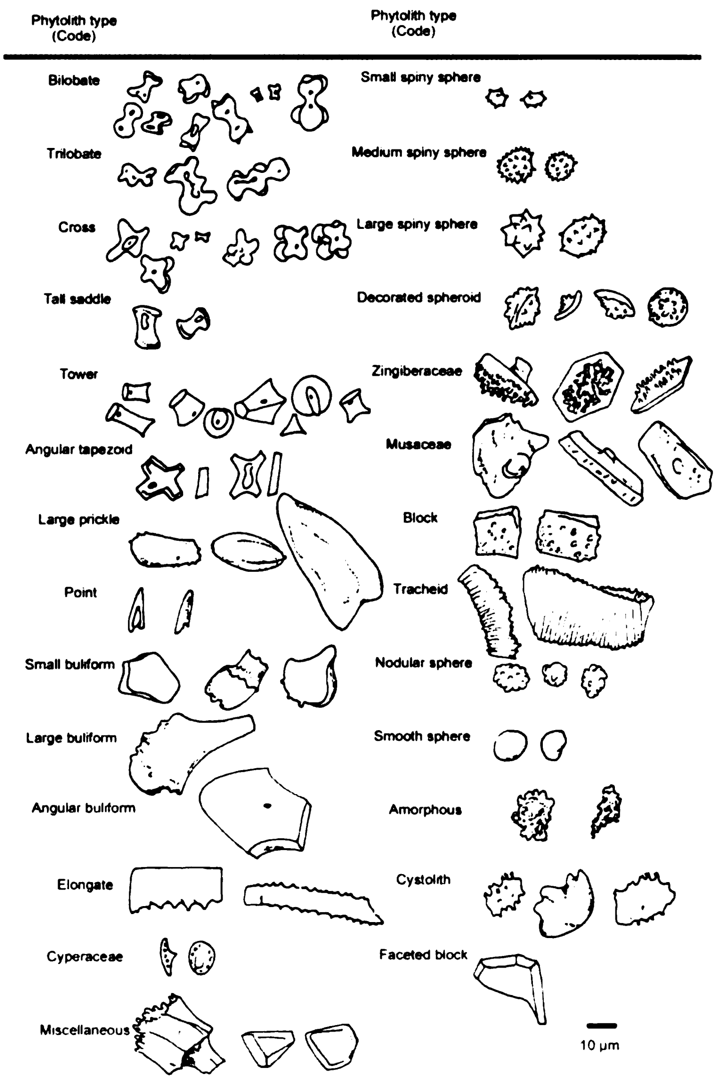


Fig. 3. Scale drawings of phytolith types and their associated codes as used in this study (Boyd et al. 1998:219).

Results

All morphotypes described in Boyd et al. (1998), Lentfer et al. (1998) and Lentfer et al. (In press) are present in the samples and their frequencies are shown in Fig. 4. Elongate phytoliths derived primarily from arboreal vegetation but also from grass species are the most common morphotype in each sample. Types typical of grasses (bilobates, trilobates and crosses) are most common in the central test pits TP 1, 2, 4 and 8, and less abundant in the samples from the other test pits, in particular TP 6 located on the adjacent southeastern ridge. Short bulliforms, probably from *Imperata cylindrica* (Fig. 5A), are also most abundant in the central test pits. Morphotypes possibly derived from bambusoid grasses, including saddles, tall bulliforms, angular bulliforms and towers, generally occur in most samples in relatively low frequencies. Towers, the most common of these, are most abundant in the central FAO site area excluding TP 7 and 8. Palm types, including small, medium and large spiny spheres (Fig. 5B), as well as

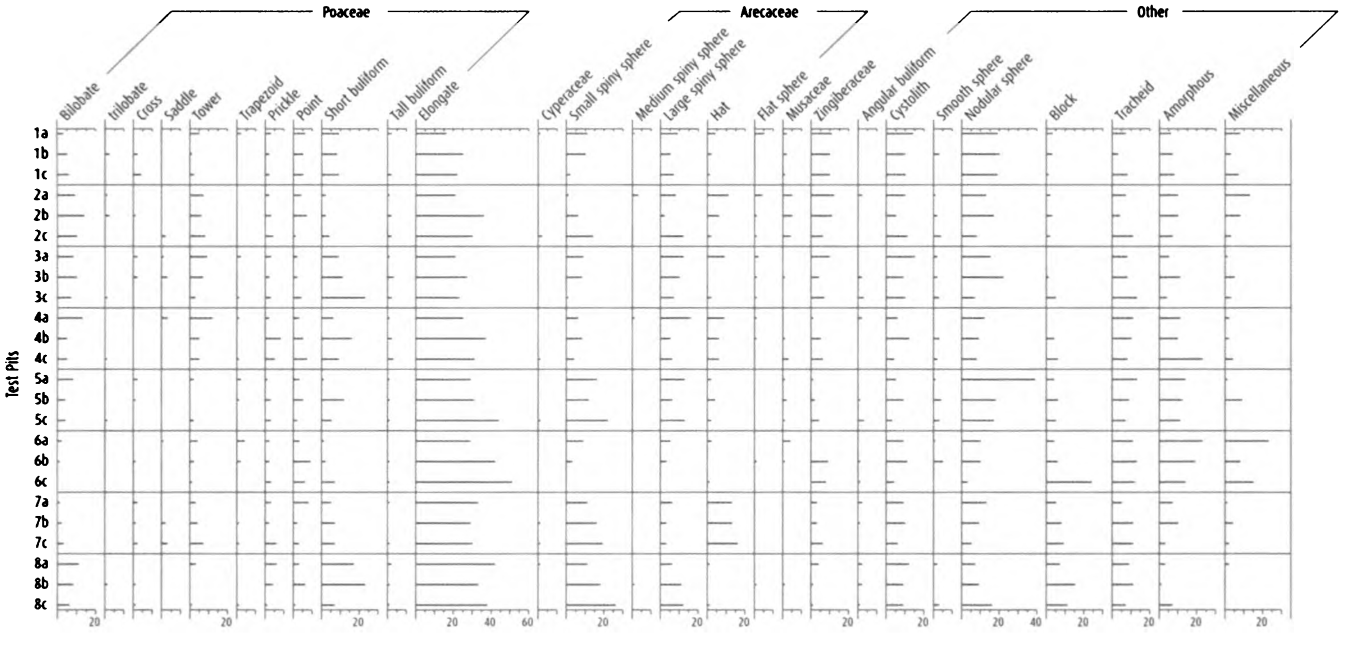


Fig. 4. Frequency of phytolith morphotypes occurring in the Lapita-period layers for all test pits.

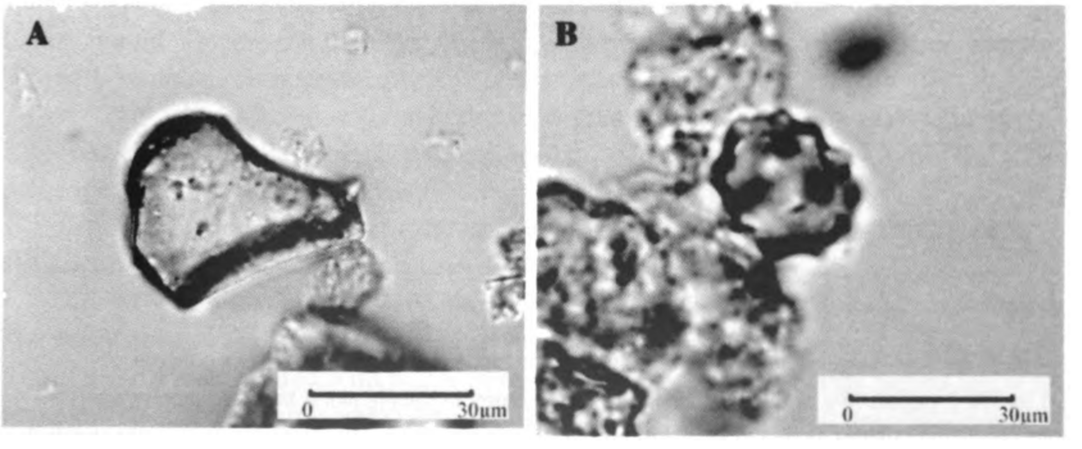
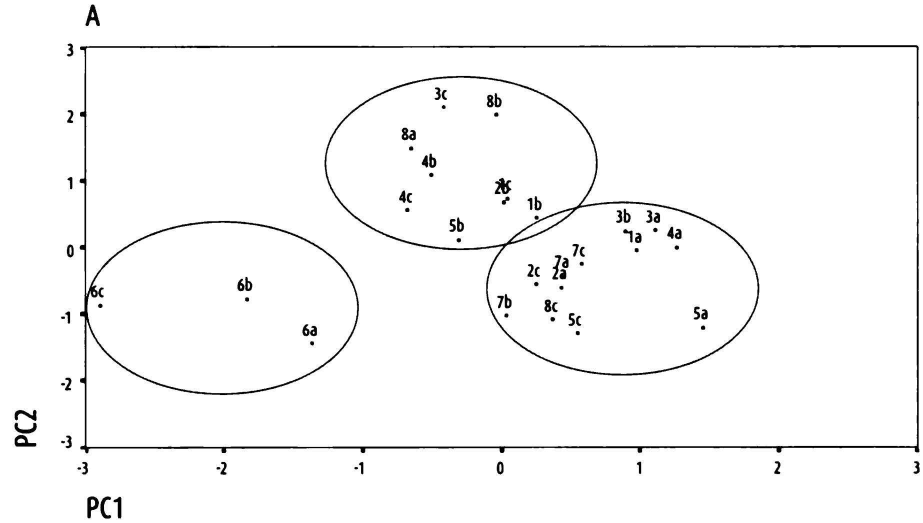


Fig. 5A and B. Phytoliths recorded at 400x magnification, (A) bulliform phytolith possibly Imperata cylindrica and (B) large spiny sphere.

Table 2. Raw data of initial and final statistics for principal component analysis.

INITIAL STATISTICS				
VARIABLE	COMMUNALITY	FACTOR	EIGENVALUE	% OF VARIANCE
Forest	1.0	1	1.959	49.0
Grasses	1.0	2	1.176	29.4
Herbaceous	1.0	3	0.653	16.3
Palms	1.0	4	0.210	5.3
FINAL STATISTICS				
VARIABLE	COMMUNALITY	FACTOR	EIGENVALUE	% OF VARIANCE
Forest	0.893	1	1.959	49.0
Grasses	0.959	2	1.176	29.4
Herbaceous	0.638			
Palms	0.644			



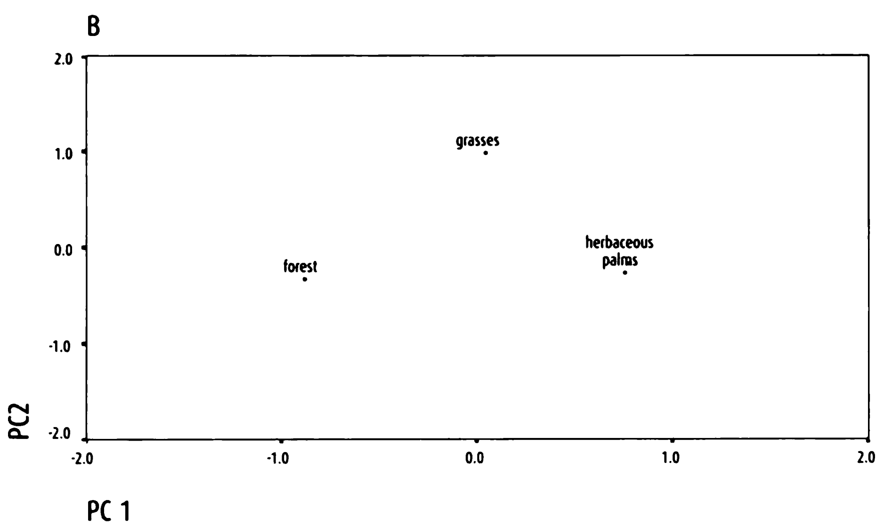


Fig. 6A and B. Biplots of analysis showing sample plot A and vegetation plot B for the first and second principal components. PC 1 and PC 2 explain 78% of the variation in the assemblages. In sample plot A the TP 6 samples are contrasted with the remaining samples along the PC 1 axis while the PC 2 axis contrasts the test pits showing the greatest disturbance during the Lapita period and those of forest and regrowth vegetation. In plot B PC 1 contrasts the herbaceous types (Cyperaceae, Musaceae, Zingiberaceae), grass types (Poaceae) and palm types (Arecaceae) with arboreal types that include elongate, blocks, smooth spheres, amorphous and miscellaneous phytolith types while PC 2 contrasts arboreal, herbaceous and palm types with grasses.

hats, are common in all test pits with the exception of TP 6. Zingiberaceae and Musaceae morphotypes were most abundant in TP 1, 2 and 3. Nodular spheres are common in all samples, but less abundant in TP 6 and 8. Some arboreal types, including blocks, tracheids and miscellaneous types occur in all test-pit samples. The latter two types were most common in TP 6.

The first two principal components for morphotypes explain 78 per cent of the variation in the assemblage (Table 2). PC 1 contrasts the herbaceous types (Cyperaceae, Musaceae, Zingiberaceae), grass types (Poaceae) and palm types (Arecaceae) with arboreal types that included elongate, blocks, smooth spheres, amorphous and miscellaneous phytolith types (Fig. 6A, B). PC 2 contrasts arboreal, herbaceous and palms types with grasses (Fig. 6A, B).

The frequency distribution and principal component analysis of morphotypes distinguish three main vegetation types amongst the samples. These are differentiated by the relative contribution of grass types, palm types, herbaceous types and forest types to each sample. In addition to spatial variation, the principal component analysis demonstrates that variation has also occurred over time in some test pits. A schematic drawing of the site area shown in Fig. 2 illustrates the distribution of test pits and associated vegetation.

Discussion

Both spatial and temporal changes are indicated by the results of the principal component analysis. The variation of vegetation within test pits is interpreted as representing an *in situ* time series within Period 2 of, broadly, (c) pre-Lapita to early Lapita period, (b) the Lapita period and (a) post-Lapita phytolith assemblage deposition. It is acknowledged that such a chronology is, by necessity, of low resolution. Nevertheless it provides a significant development over the previously identified Period 2 as encompassing some 2300 years. The results show clear patterns of variation in vegetation types at, and around, the FAO site. TP 6, in particular, which is located at a distance from all other test pits on the southeastern ridge, is clearly differentiated from the other test pits by the comparatively high component of forest types. The forest types are dominated by large granulated globular forms that sometimes appear as conglomerates of siliceous material. Morphotypes such as these have been described as being associated with arboreal plants (Sharma et al. 1970; Welle 1976). Although the frequency distribution of phytolith types (Fig. 4) shows the range of variation in each test pit, the principal component analysis defines the dominant vegetation types represented in each sample. A summary of the spatial and temporal variation of vegetation for all test pits is provided below.

TP 1 is predominantly cleared grassland throughout the pre-Lapita, early-Lapita and late-Lapita period. During the post-Lapita period, however, TP 1 has a herbaceous component possibly associated with some regrowth.

TP 2 has a palm and/or herbaceous component during the early and pre-Lapita period. Alternatively, during the main Lapita period, TP 2 is dominated by grass types but returns back to a palm and/or herbaceous component during the post-Lapita period.

TP 3 contains grasses in the early and pre-Lapita period but contains a strong herbaceous element in the Lapita and post-Lapita periods.

TP 4 has cleared grassland throughout the pre-Lapita, early-Lapita and late-Lapita period. The post-Lapita period has a herbaceous component.

TP 5 is associated with palms in the pre-Lapita and early-Lapita period but is predominantly grassland during the main Lapita period. During the post-Lapita period the vegetation is dominated by herbaceous and palm types.

TP 6 is dominated by forest types throughout the post-Lapita, the Lapita period and pre-Lapita to early-Lapita periods.

TP 7 has a herbaceous and palm component in the early and pre-Lapita periods but is predominantly associated with palm types in the Lapita and post-Lapita periods.

TP 8 contains a palm component in the early or pre-Lapita period, but is dominated by grasses in the Lapita and post-Lapita periods.

A synthesis of the above data suggests that during the Lapita period all samples in the central site area TP 1, 2, 3, 4 and 8 are predominantly grassland, therefore providing some evidence of clearing. However, with the exception of TP 8, all test pits in the central site area change in plant composition during the post-Lapita period to herbaceous and/or palm vegetation types. Such a change may be indicative of a fallow period. On the other hand, TP 8 continues to be dominated by grass types in the post-Lapita period indicating continued disturbance. TP 6 and 7 have no significant evidence of vegetation change through time which probably indicates relatively little disturbance. TP 7 vegetation remains predominantly palm dominant, while TP 6 has a continuous forest presence throughout the periods represented by the samples.

The nodular sphere morphotype (Fig. 4) is probably derived from the Euphorbiaceae family (Kealhofer et al. 1998) that comprise an important group of pioneer species and secondary regrowth plants in the West New Britain region (Lentfer 1995; Lentfer et al. In press). The modest representation of this phytolith type in TP 6 samples may be indicative of very low levels of disturbances. Alternatively, while a small forest element is indicated for other test pits (Fig. 4) these morphotypes are predominantly nodular spheres and therefore are most likely associated with regrowth. Grasses, palms and herbaceous types have a stronger influence in these assemblages.

Collectively, the data indicate that during Period 2 various levels of disturbance occurred in and around the FAO site area (Fig. 2). The short bulliform morphotype indicative of *Imperata cylindrica* has a relatively strong presence in test pits TP 3, 4 and 8 providing evidence of disturbance during the Lapita period in the central site area, and indicating that this part of the site, in particular TP 8, was subjected to relatively greater human activity than the surrounding areas.

These test pits also provide evidence for a pattern of regrowth across this area indicating that while the vegetation appears to have had an episode of clearing (perhaps for the garden plots that Kirch (1997) has suggested occurred throughout the region during the Lapita period), it has not been continually disturbed allowing regrowth to occur. TP 8 is the exception to this pattern and appears to have been continually disturbed. Vegetation on the southeastern ridge appears to have experienced only minor disturbance in comparison to the other test pit areas, having been predominantly associated with forest throughout Period 2.

In conclusion, it is noted that the considerable variability of vegetation found both within and around the site through time reinforces the idea that the analysis of a single stratigraphic profile to determine the nature of past vegetation types and aspects of human activity may be inadequate at archaeological sites, especially those in open contexts. For palaeoenvironmental analysis, therefore, a number of samples are required from nearby locations to allow a reliable palaeolandscape reconstruction using fossil phytoliths. Through the spatial analysis of contemporaneous fossil phytolith assemblages this study has provided the first palaeoenvironmental evidence in the Papua New Guinea region able to identify within-site patterning of vegetation disturbance from those more strongly characterised by the presence of natural vegetation types. Most importantly, the study demonstrates that, across a localised area, the spatial analysis of fossil phytolith assemblages can provide detailed data for human land-use patterns and palaeoenvironmental reconstruction. Specifically, at this site, it is now possible to demonstrate the presence of increased disturbance presumably leading into the Lapita period and the subsequent onset of vegetation regeneration.

Acknowledgements

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Tattooed faces from Boduna Island, Papua New Guinea

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Introduction

As demonstrated by Spriggs (1990), the depiction of human faces, generally in a very stylised manner, is an integral part of the design system used on Lapita pottery; the faces may also have had a symbolic role (Kirch 1997:133–140). To date, nearly all the faces known are two-dimensional representations on ceramic vessels, although one is also carved on a bone (Kirch 1997:frontispiece). A modelled ceramic head was found at site NKM001 at Koumac, New Caledonia, by Frimigacci (1981) and is illustrated in Sand et al. (1996:122, Fig. 162) and Kaeppler et al. (1997:Pl. 109). Recently, Summerhayes (1998) reported a small modelled ceramic head with eyes and a nose which, like the ?buttocks previously found by Green (1979:Figs. 1–2) in the Reef Santa Cruz Nenumbo site (SE-RF-2), may have been part of a figurine, although attachment to a pot is also possible (Summerhayes pers. comm.). We report here the discovery of three ceramic faces from Boduna Island (site FEA), West New Britain, Papua New Guinea (cf. Ambrose and Gosden 1991). These new finds add a further ingredient to the Lapita repertoire because they incorporate both elements of previously known faces. The Boduna faces are probably parts of ceramic vessels and not free-standing like the figurine fragments, but, unlike the faces discussed by Spriggs (1990) and Kirch (1997), they are modelled in three dimensions. In addition, two of the faces have dentate-stamp designs which may represent tattooing and may therefore provide added support for the proposal by Green (1979; cf. Kirch 1997:142) that tattooing and dentate stamping were part of the same stylistic system.

Boduna faces and context

The faces were found by Mr John Ray of Kimbe, an avocational collector, who has amassed a large assemblage of Lapita pottery from site FEA on Boduna Island. They were recovered on the sea bed under shallow water just off the current shore of the island. The three faces are naturalistic to the extent that they are modelled in three dimensions. All were either clearly incorporated within the body of a pot (Faces 2 and 3) or have a rough flat surface behind the face as if it had been detached from a larger clay body (Face 1). All three are rolled or abraded to some extent and so some features have been obscured.

Face 1, about 7.7 cm high, is marked by recesses for the eyes (Fig. 1). A long straight nose with well-defined, slightly uptilted nostrils runs down from the eyebrows. The eyes are designated by a stamped circle embraced by two pairs of dentate-stamped arcs forming an almond shape. The marking is clearer around the left eye (Fig. 2). At least two more dentate arcs run across the cheek underlying the eye and may have been matched by two more running above the eyebrow. The cheek markings are similar to arcs below the eyes in the simpler two-dimensional cases (e.g. Green 1979:23, Figs. 1–4 middle right; Kirch 1997:135, Pl. 5.5). There is also a faint suggestion of additional dentate stamping on the cheeks in the form of a vertical pair of arcs enclosing an oval space.

Face 2 is about 6 cm high and was red slipped (Fig. 3). As shown in side view (Fig. 4), it is clearly from the side of a pot. The face is flat and only the nose appears in relief. The nose is proportionately much shorter and stubbier than that on Face 1 and, although well defined, the nostrils are not tilted. The right eye, the only one preserved, is outlined by a pair of dentate arcs. A stamped line below the eye runs at a sharp angle to the nose. Three bands of dentate-stamped rope motif loop across the forehead, recalling a similar pattern around the drawn face found by Green at SE-RF-2 (Green 1979:Figs. 1–3, 1–4) and others of Spriggs' single face type (cf. Kirch 1997:137, Fig. 5.5).

Face 3, about 5 cm high, is more heavily rolled than the others and only the nose and nostrils are clearly visible (Fig. 5), although the eye sockets are slightly recessed and were also probably moulded. No dentate stamping has been preserved.

The Boduna site where the faces were found consists of a low coral islet covered with sand and volcanic tephra. It is located off the Willaumez Peninsula in Garua Harbour about 1500 m north of Garua Island. Survey and excavations during the Lapita Homeland Project showed that sherds and obsidian were found over most of the dry surface and within a probable buried soil which has formed a beach rock in some places (Ambrose and Gosden 1991). Most of the sherds illustrated in the report are rolled and while the designs are geometric, not all of them are highly coherent. They mainly appear to fit within the 'Western' phase of Lapita pottery (Ambrose and Gosden 1991:187). Recovery of a bifacially flaked obsidian tang (Ambrose and Gosden 1991:187, Fig. 7) shows that the island may also have been used by earlier inhabitants of the area (cf. Torrence et al. 1990:460). There are four dates on shell from the site (Ambrose and Gosden 1991:187; Specht and Gosden 1997:195) and three appear to be around 3000–2800 cal BP, which fits the 'middle, Western' style of the pottery (cf. Summerhayes 2000).

Ray's collection of pottery from Boduna compares favourably with the illustrations in the published report, but also includes some relatively large, well-preserved sherds with quite intricate and very finely stamped geometric designs characteristic of 'Early Far Western' Lapita. Recognisable forms include shouldered vessels and pot stands. Several cut-outs are also present. It is interesting that Ray's assemblage contains different elements from the surface collections and excavated material of the Ambrose and Gosden (1991) archaeological work on Boduna, particularly in terms of the more ornately decorated sherds. Since these are derived from shallow water, it is possible that their distribution was restricted to particular structures, as in the case of the Talepakemalai site described by Kirch (1997:140) where the anthropomorphic designs were "discretely associated with the stilt houses that formerly stood over the shallow reef flats". Analysis of material excavated from the centre of Boduna Island in 1989 by Specht and Summerhayes (pers. comm.), however, indicates that both early Far Western and middle Western Lapita ceramic fabrics are present in other areas of the island where they may be differentiated stratigraphically.

Implications

The discovery of these three naturalistic faces ('analytical figurative' in Leroi-Gourhan's terminology; see Kirch 1997:294 n.15) raises several interesting questions. There are four other three-dimensionally modelled faces known to us: (1) the bone figurine dominated by its face from Talepakemalai (ECA)

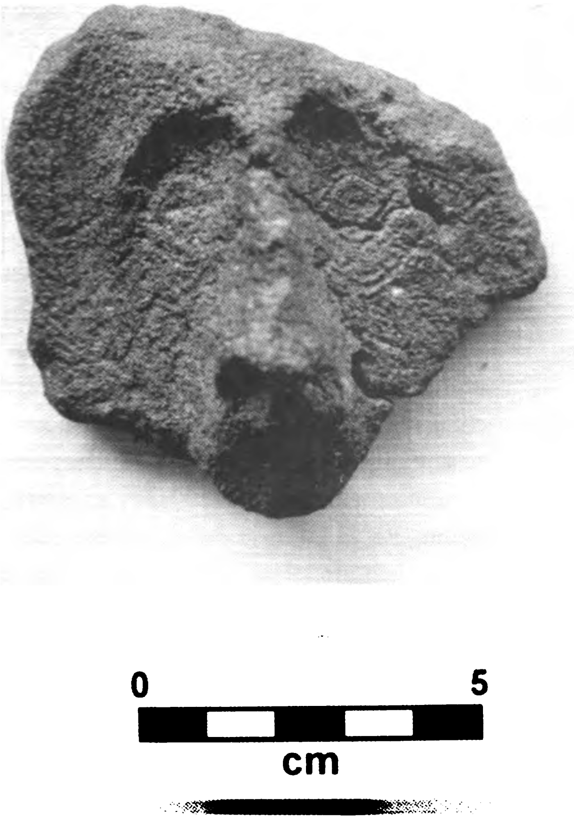

Fig. 2. Face 1, detail of dentate stamping on left eye and cheek. See Fig. 1 for scale (Photo Paul Ovenden).

Fig. 1. Face 1, vertical view. Four dentate-stamped arcs underline the eye and another faint stamped design is visible on the cheeks (Photo J.P. White).

Fig. 4. Face 2 viewed from the right side showing both the projecting nose and the clear incorporation of the face into a ceramic vessel. See Fig. 3 for scale (Photo J.P. White).

Fig. 3. Face 2, vertical view. A pair of dentate-stamped lines set diagonally across the right cheek is clearly visible and a rope design has been placed on the forehead (Photo Paul Ovenden).

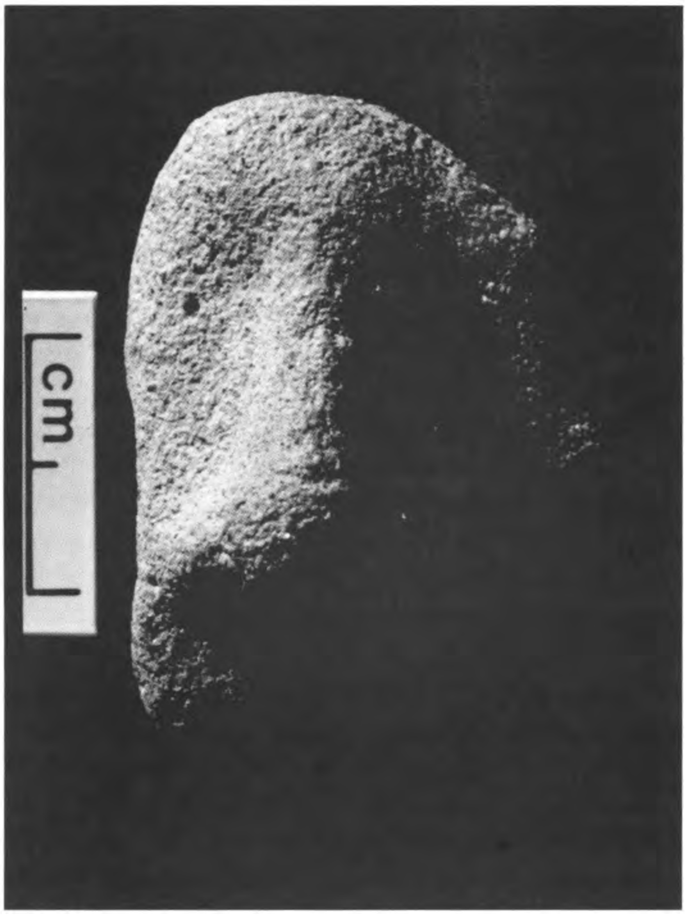

Fig. 5. Face 3 shown from a slight angle to highlight the moulded nose, nostrils and eye sockets. No decoration has been preserved (Photo Paul Ovenden).

(Kirch 1997:iii); (2) a moulded ceramic head found by Frimigacci (1981) at NKM001 in New Caledonia; (3) the ceramic head recently reported by Summerhayes (1998) from the Kamgot (ERA) site on Babase Island; and (4) an unpublished moulded face from the Naigani site, Fiji (Best 1981:11). The Naigani example was found on the surface with two others (representing an animal head and a ?torso) by a local collector and so its context is insecure. Best (pers. comm.) feels that if they are genuine prehistoric objects, they probably belong to the time of Polynesian plain ware, rather than decorated Lapita pottery because of their surface context and the presence of impressed holes on one of the figurines similar to those on an object from a plain ware context at the Lakeba site.

In the Talepakemalai bone figurine the eyes are horizontal engraved slits rather than dentate arcs, although the elongated nose is shared with the Boduna ceramic faces. The Koumac head also shares a relatively long nose, but has very deep eyes. It has dentate stamping around the eyes (Sand pers. comm.). The Babase face is much smaller than the Boduna faces. It shares the features of eyes outlined by a pair of arcs and a prominent nose, but differs because nostrils are not present. The dentate-stamped designs on the nose and forehead of the Babase head and the cheeks of the Boduna faces are unique.

More stylised ('synthetic to geometric figurative') two-dimensional faces drawn on the surface of pots are known from many Lapita sites (review by Spriggs 1990:83–84 with additions from ECA (Kirch 1997:132–139), SEE (White and Harris 1997:Fig 2) and possibly FOH (Summerhayes 2000:Fig 5.36)). The most naturalistic of these is from the Reef Santa Cruz SE-RF-2 site in which the modelling for the eyebrows and nostrils is represented by dentate arcs (Green 1979:22, Figs. 1–3). It is these two-dimensional, drawn faces which have dominated discussion to date and led to the suggestion of links with the designs on bronzes from mainland and Island Southeast Asia (e.g. Newton 1988 among others). The two-dimensional designs, however, may have been derived from naturalistic, three-dimensional forms.

Although their naturalistic features are of interest, what is most important about the faces is the use of modelling to create a three-dimensional view. Other attempts to add a three-dimensional aspect to Lapita ceramics comprise cut-outs, which mainly occur in early assemblages, and the increasing use of appliqué (e.g. 'knobs' and 'sausages') over time, but neither of these were ever very common nor are these approaches very closely linked to the modelling technique used to make the faces.

Green (1979) proposed that dentate stamping on pottery suggested the presence of similar decorations in bark cloth and tattooing. Later he proposed that dentate stamping on ceramics was an extension of the decorative system from bark cloth and tattooing (Green 1985). If, however, the Lapita stylised faces originally derive from or at least parallel figurative models, then their existence may mean that there were naturalistic antecedents for the two-dimensional faces within the Lapita artistic tradition. What we may be witnessing is the combination of dentate stamping with a previous tradition of three-dimensional art, most likely involving carving.

Most recently, Kirch (1997:142) has proposed that the origin of the Lapita design system on ceramics was the extension "specifically from *tattooing to ceramics* because the dominant technique used to decorate the clay was the same as that used in piercing the skin" [original emphasis]. He goes on to suggest that the pots themselves were being tattooed and because faces are commonly depicted, they represented "human beings, living or dead, real or mythical" (Kirch 1997:143). Kirch's hypothesis has one weak link: very few of the two-dimensional, drawn faces on pottery appear to bear tattoos. Instead, dentate stamping is mainly used to designate facial features, particularly the eyes. In contrast, the modelled faces from both Babase and Boduna are decorated in the manner of tattoos. These include lines of dentate stamping on the nose and the impressed circle on the forehead of the Babase head and the lines of dentate stamping on the cheeks of Boduna Faces 1 and 2. The newly discovered modelled faces therefore raise some interesting questions: were the two- and three-dimensional faces symbolic depictions of different phenomena or were they simply variations on a single meaning?

Conclusions

In summary, the three modelled faces from Boduna Island are significant because they enlarge the range of techniques used to depict human faces on Lapita pottery and they strengthen the relationship between tattooing and dentate stamping. The finding of additional examples of three-dimensional art in a putatively early-Lapita context also suggests that carving may have played a more important role in the art forms at this time than has been previously suspected. The modelled faces therefore provide a small window into the much wider world of three-dimensional perishable materials that might have been used alongside the ceramics.

Acknowledgements

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Phallus-shaped and other ceramic handles of Vanua Levu, Fiji

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Introduction

Preliminary investigations at three archaeological sites at Malau, Vaturekuka and Buasoli on the island of Vanua Levu, Fiji (Fig. 1), have produced some noteworthy lithic and ceramic discoveries, the earliest of which fall within the Lapita period. The focus of this account is on the identification and description of a number of types of ceramic handle. These include unusual phallus-shaped vertical handles of pot covers, an apparently unique form of polygonal handle, and a variety of horizontal and vertical looped handles, one of which bears a unique incised representation of what appears to be a bird. These handles vary in shape, thickness, method of production and technique of attachment of the handle to the cover or main body of the vessel.

Investigations have yielded no directly associated dating evidence in relation to the handles. Nevertheless, Lapita pottery and a plano-convex highly polished basalt adze typical of the Lapita period have been found in the same general context as the phallus-shaped handles, and William Dickinson (1997) has determined that a Lapita sherd from Vanua Levu contained temper looking megascopically similar to two sherds from the Malau and Vaturekuka sites. It has been suggested elsewhere (Parke 2000) that the phallus-shaped handles may be contemporary with the Eastern Lapita period, perhaps dating to 2900–2700 years ago (Anderson and Clark 1999:37).

The initial discovery of each of these sites was made accidentally in 1967 and 1968, and subsequent investigations were carried out on a number of occasions at the sites at Malau and Vaturekuka. No controlled excavation has yet been carried out. The location of each site and the forms of the handles will now be described in the context of other finds made at these sites.

Malau

The site at Malau in the province of Macuata in northern Vanua Levu is on a sandy beach through which rocks protrude. It is separated from a cliff to the south by a flat area up to half a kilometre wide. The beach is sheltered from the open sea to the north by the island of Mali. The initial discovery of the

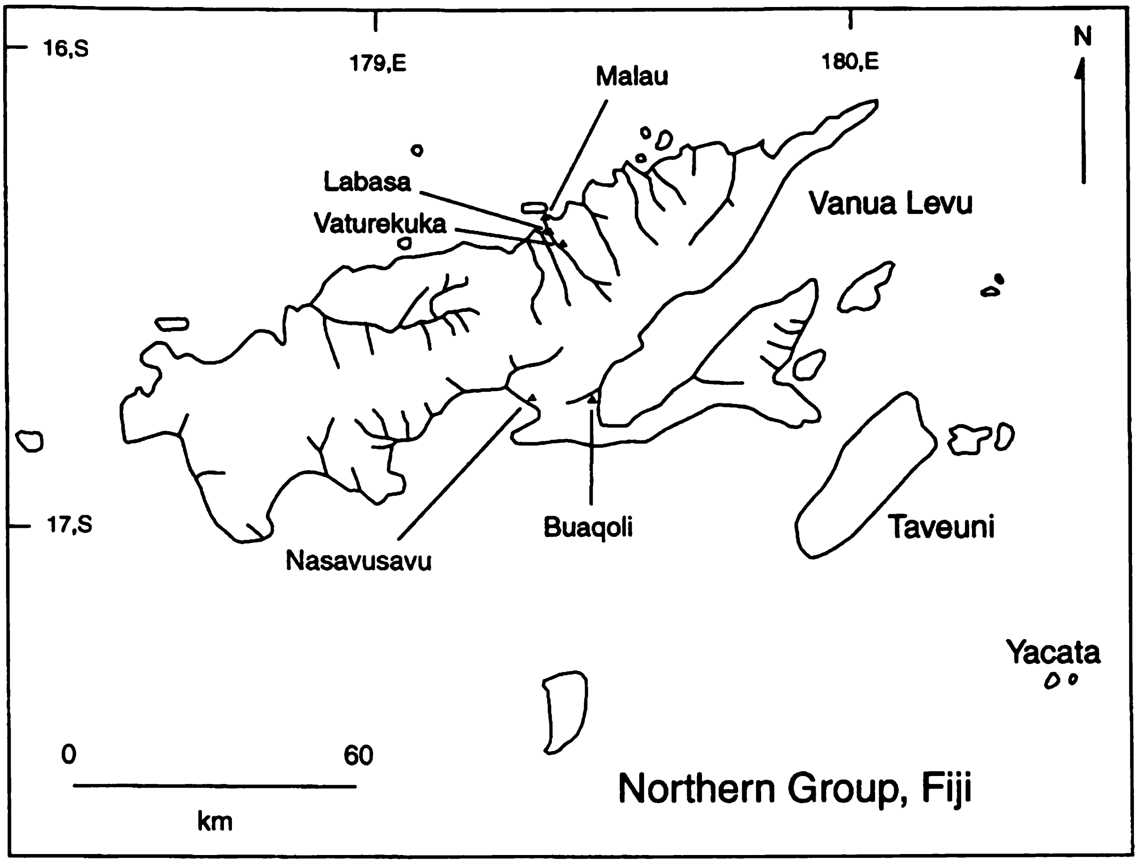

Fig. 1. Map of Northern Division, Fiji.

site was made accidentally during a family stroll along the beach, following a storm which had resulted in the top of the sand being eroded away and phallus-shaped handles emerging like mushrooms from the remaining sand. Subsequently, other visits were made to the beach, especially after a storm, and sherds continued to be laid bare. The sherds were of a variety of handle types, mostly broken, as well as rim and body sherds. One complete pot apparently containing ashes was reported to have emerged from the sand, but by the time I managed to investigate the discovery on the following day, the tides had swept away and shattered the pot. I was, however, able to find a collection of ashes, identified as human by A.H. Thomson, the Senior Dental Officer on the staff of the Colonial Memorial Hospital, Suva, as well as a few body sherds of greyish Fijian pottery typical of Malau which were lying near to the ashes. Any suggestion that the discovery represented the remains of a Hindu cremation is unlikely, because of the nature of the pottery apparently associated with the ashes.

Handle Type 1: Phallus-shaped

Fig. 2 illustrates examples of phallus-shaped handles, of which nine were found at Malau (Fig. 2A, C–G, J). A typical handle is in the form of a vertical shaft with a terminal knob, usually with a rounded top, and a waisted middle portion. This type of handle is identified as that of a cover of a vessel rather than as a pot stand, because the rounded top of a terminal knob would have precluded free-standing, and even the relatively flat-topped ones stand unsteadily. As far as can be determined without damaging the surviving part of a handle, this type of handle was made by direct moulding from clay slabs which formed the upper part of that cover (Fig. 3A–B). No example was identified which suggested that the handle had been made separately and was later inserted into a hole in the top of the cover. The handles and covers were generally of hard grey ware. The stoutest of the handles was 40 mm in diameter and the tallest was 5 cm high. The covers were about 10 mm thick. Only two relatively squat handles were made of red-brown ware.

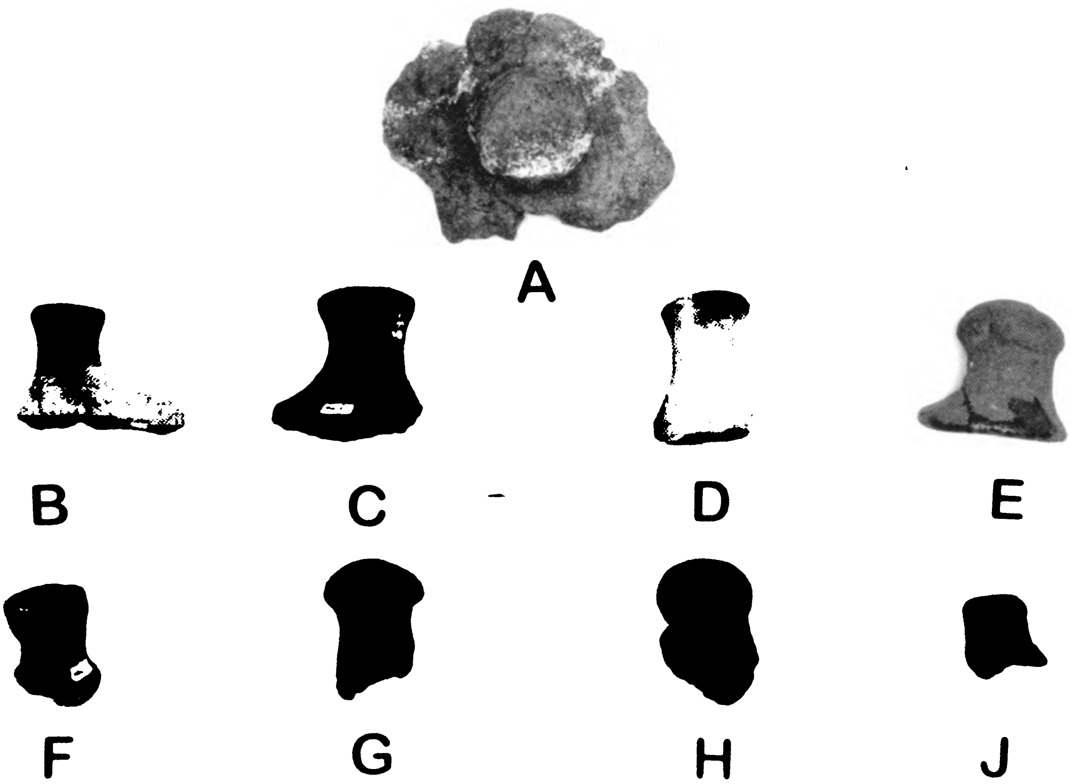

Fig. 2. Selection of phallus-shaped handles from Malau (A, C–G and J), Vaturekuka (H), and Buaqoli (B).

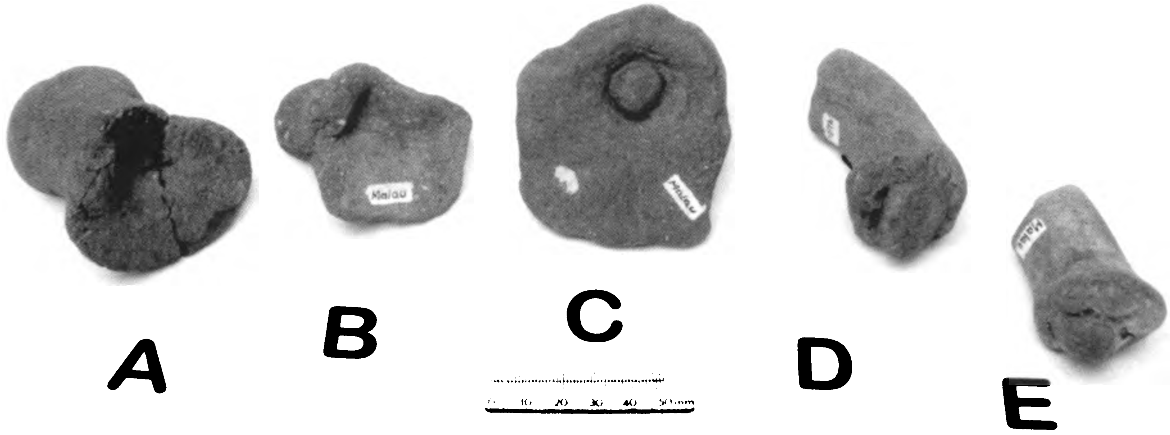

Fig. 3. Examples from Malau of methods of affixing handles to bodies of pots. Direct moulding (A and B). Insertion (C–E).

There is as yet no direct evidence for the dating of these easily recognised handles. Although no sherds of the pottery discovered at Malau have been positively identified as of the Lapita period, a rectangular, highly polished basalt adze (45 mm × 35 mm × 15 mm) was retrieved in the general area where the phallus-shaped handles were found. This was recognised as typologically within the Lapita period adze kit (Summerhayes pers. comm.).

Handle Type 2: Polygonal

The polygonal handle found at Malau (Fig. 4A) is the first of this type so far found on Vanua Levu or, as far as can be determined, on any archaeological site in Fiji or the neighbouring territories. It may have been manufactured separately from the main body of the vessel or it may have been moulded into the body. Either way, it is difficult to tell whether it was fixed horizontally or vertically to the pot. The handle as it survives comprises a base piece on the side of the pot; two outward curving, lower side pieces (31 mm long), joined to the base piece; a slightly curved upper piece (25 mm long); and two straight upper side pieces (40 mm long) connecting the upper piece to the two lower side pieces. Each piece of the resulting hexagon is about 35 mm wide and 20 mm thick, being slightly rounded on the outer side. The inner side of the handle is hollow, forming a hole roughly oval in shape (30 mm × 21 mm), and narrowing towards the innermost part of the hole which has been smoothed inwards from each end. The handle appears to be made of the same material as that of the phallus-shaped handles, and may be contemporary with them.

Sherds representing some 20 horizontal or vertical looped handles were also found on Malau beach. The dating of these handles and their relative sequence remains obscure. They varied considerably in thickness, form and manufacture.

Handle Type 3: Horizontal looped

Only one handle (Fig. 5A) was in such a complete state of preservation that it could be identified as probably horizontal. It was semi-circular in pattern (18 cm on the outside) and round in section (32 mm). Made apparently of one piece of clay, it was red-brown in colour. It had been made separately and fitted into the body of the vessel through two holes previously made in the body of the pot. Its form resembles that of the pair of horizontal circular handles inserted into the upper part of the body of a hemispherical vessel of the Plum tradition found in New Caledonia and dated to the first millennium AD (Sand 1998:19).

Handle Type 4: Vertical looped/oblique-angled

The vertical looped handles fall into two categories based on thickness. The two thickest and most massive handles were round in section, between 40 and 43 mm in diameter, dark grey in colour and rough in texture (Fig. 6A, B). The precise form of these handles is not evident from the surviving parts. The smoothest of the massive handles (Fig. 6A) had traces of incised curvilinear designs. The designs will be described and discussed separately on another occasion.

The maximum width of the less-massive types of handles was 31 mm (Fig. 5B–E, H). They were mostly oval (30 mm x 28 mm), flattened oval (31 mm × 18 mm) or kidney-shaped (30 mm × 18 mm with a 2 mm deep concave channel in the middle of the underside of the lower part; Fig. 6C). The oval handles were evidently made separately and inserted into holes in the body of the vessel (Fig. 3C–E). These handles were grey or red-brown in colour.

In one of the two examples of vertical angled handles (Fig. 5F–G) the length of the longer surviving part which was oval had been penetrated by a hole between the angle and what may have been that part of the side of the vessel to which the handle was attached. The part of the handle leading from the angle with the other part was solid and flatter in section. The other example, which was round in section in one part and oval in section in the other surviving part, showed no sign of a hole.

Handle Type 5: Channelled protrusion

One enigmatic sherd of grey colour appears to be the end of an channelled handle or protrusion from the body of a vessel (Fig. 4C). Oval in section, the upper part has been hollowed out in the form of a channel. It bears some resemblance to an almost complete 'handle' and a partial handle which I found on Yacata, an island some 80 km southeast of Vanua Levu (Fig. 4B, D). The Yacata 'handle' was 60 mm long, 40 mm across, 20 mm at its thickest part, and 14 mm thick at the deepest part of the 'channel' on the upper surface. The site at Yacata has produced dentate-stamped and other Lapita sherds, as well as other types of pottery and artefacts such as shell bracelets (Clark and Hope 1997; Parke 2000). Among the sherds I found on Yacata was part of a vertical looped handle, oval in section. The upper part merged with the rim of the vessel to which it appears to have been moulded.

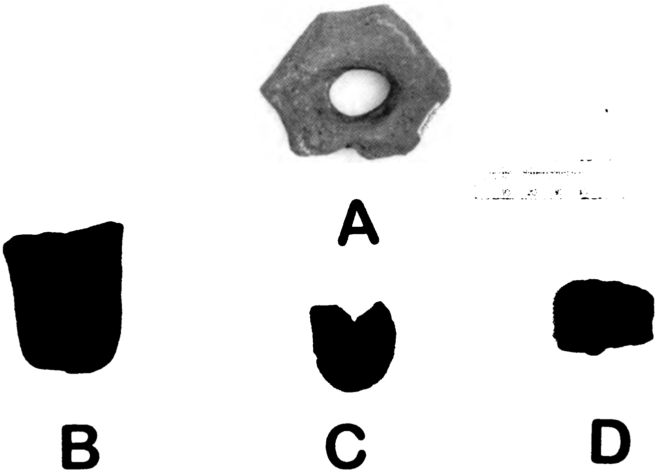

Fig. 4. Polygonal handle from Malau (A). Channelled handles or protrusions from Vaturekuka (C) and Yacata (B and D).

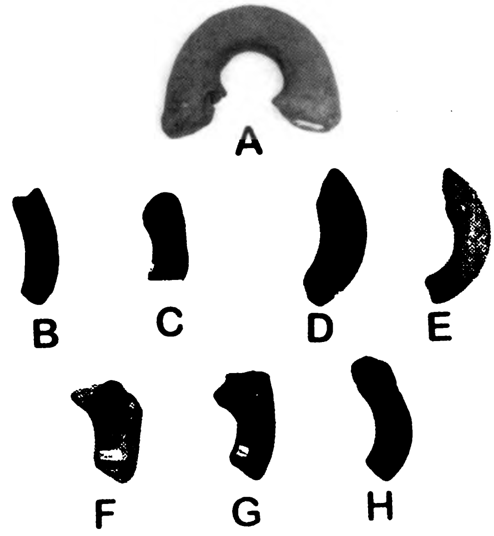

Fig. 5. Horizontal looped handle from Malau (A). Vertical looped handles (B–E, H), and vertical angled handles (F and G) from Malau.

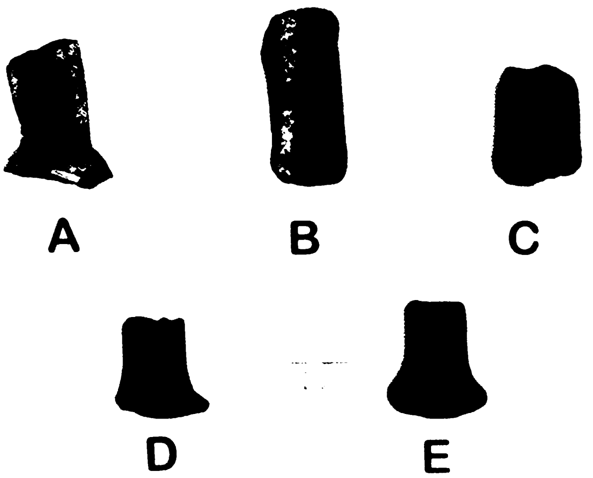

Fig. 6. Massive vertical looped handles from Malau (A and B). Vertical looped handles from Vaturekuka (C–E).

Fig. 7. Phallus-shaped handle and cover from Vaturekuka.

Vaturekuka

The site of Vaturekuka is also in the province of Macuata, about 7 km south of the beach at Malau. It is on the east bank of the Qawa River in a flat river valley, about 4 km inland from the present mouth of the river which flows northwards past the town of Labasa into a broad bay. It is overlooked by the hill and Vaturekuka Government Station, where I lived at the time of the site's discovery. A road runs parallel to the east bank of the river at the point where the site was identified and the Public Works Department had been dredging soil and gravel from the river and dumping it on the bank. Stopping to investigate, I saw that a number of pot sherds had been dredged from the river. Over the period of a year or so, I continued to monitor the activities of the Public Works Department, assisted by the Road Supervisor and his workmen who put aside sherds as they noticed them. These activities resulted in the accumulation of a considerable collection of rim and body sherds of the early, middle and late periods within the Fiji ceramic series, showing a variety of decorations including dentate-stamping, notching, nubbins, paddle-impression and incision.

David Burley (Simon Fraser University) and Glenn Summerhayes (Australian National University) assisted in the identification of the Lapita-period sherds. I have reported separately (Parke 2000) on these Lapita-period discoveries, which included a dentate-stamped rim sherd, six sherds from carinated bowls showing traces of a red slip, and parts of a shallow bowl, ca. 65 cm in circumference, with a notched rim. Together with these sherds was found an oval pottery disk, 50 mm × 40 mm, similar to that found by Gifford at Navatu (1951:270) in the northeast of Viti Levu, in a level producing paddle-impressed ceramics; and somewhat similar to some of the oval pottery discs found by Birks at Sigatoka (Birks 1973:40) and by Gifford and Shutler at Lapita, New Caledonia (1956:124). Nearly all the discs at Sigatoka came from Level 1, the Lapita-period layer. The Vaturekuka disc showed no signs of a small drilled hollow near the centre on one side such as occurred on several of the Sigatoka discs. The use of such discs remains obscure. A rectangular, highly polished adze, 55 mm × 35 mm × 15 mm, possibly of Samoan origin, was among the material recovered at the site.

Handle Type 1: Phallus-shaped

Compared with the finds at Malau, the number of handles retrieved was relatively small. Only two phallus-shaped vertical handles were positively identified. One was associated with at least four sherds which fitted together and formed a major part of the cover of a pot, including the handle (Fig. 7). The handle, of which only the lower part survived, was almost certainly moulded into the body of the cover, and there is no indication that it might have been inserted into a hole in the top of the cover. The cover was red-brown in colour, with some dark stain inside the dome. It was 10 mm thick just beside the handle, and narrowed to 3.5 mm at the rim which had not been notched. The cover was about 25 cm in diameter. This cover contrasts in several respects with those found at Malau, especially as regards thickness and colour. The other (Fig. 2H) is red-brown in colour, and contrasts with the Malau handles in that it was inserted into a hole in the top of the cover. As in the case of the Malau phallus-shaped handles, there was no direct dating evidence for these two phallus-shaped handles. Further, excavation by river dredging is hardly conducive to the reaching of any positive conclusion about relative dating by association or stratification. The dating of the phallus-shaped handles must remain an open question for the moment. Future investigations should, however, hopefully provide some substantial evidence to support the few clues as to the dating of the handle. Such dating is at present based on the handle's possible association with a number of sherds of the Lapita period and such articles as the oval pottery disc.

Handle Type 4: Vertical looped

The other handles were either vertical looped or vertical angled. They were generally oval in section, and their maximum width was about 30 mm. As far as could be determined from the few relevant parts of diagnostic sherds discovered, the handles were moulded with the sides of the vessel or were made separately and inserted into holes in the side of the vessel (Fig. 3C–E). At this stage, no suggestion is made as to their dating or relative sequence with each other or, indeed, with the phallus-shaped handles.

Buaqoli

The third of the sites on Vanua Levu where I found phallus-shaped handles was at Buaqoli on the south side of the island, about 10 km east of Nasavusavu. It is situated about half a kilometre inland from the coast, by a shallow estuarine river. The site was discovered by accident in the course of a routine administrative visit to villages in the area. Following the river inland from its mouth, it was evident that a considerable area of the river was being exposed at low tide. Investigation along and from the west bank revealed a number of sherds lying on the gravel of the river bed. The majority of sherds retrieved were featureless body sherds, but there was one phallus-shaped handle similar in shape and hardness to those found at Malau (Fig. 2B).

Handle Type 1: Phallus-shaped

This vertical handle (Fig. 2B) was round in section, with a terminal knob and a slightly rounded top. It had a waisted middle portion. The handle was evidently moulded into the upper part of the cover. The pottery of the cover was red-brown outside and black inside. It was very hard in texture.

Unfortunately I did not have an opportunity to return to this site, which was on the other side of the dividing mountain range from where I lived since at that time there was no road over the range, as there is today.

Discussion

To date, the archaeological map of the island of Vanua Levu has been a virtual blank as far as the published record of early sites and discoveries is concerned. This paper aims to provide a preliminary report on phallus-shaped handles as a type of ceramic which, as I have suggested elsewhere (Parke 2000), may be contemporary with the Lapita period. Examples of two ceramic characteristics of the Lapita period, dentate-stamped decoration and carinated bowls, have been found at two of the three sites investigated on Vanua Levu. Examples of the phallus-shaped handle have been found at all three sites.

This phallus-shaped type of handle is similar in form to the two found by Birks at the Sigatoka Sand Dune Site, Fiji, and associated with Type 4 vessels or covers (Birks 1973:29). Both were found in Level 1, the earliest layer, in which dentate-stamped Lapita sherds were also found (Birks 1973:27). These two handles were red-brown in colour, one top was flat and the other was slightly convex, and both had been made separately from the bodies and later "inserted into the hole in the bowl part and the clay moulded round it to bind the two together" (Birks 1973:29). Christophe Sand, of the Archaeology Department, Museums and Heritage Service, New Caledonia, has looked at the Malau pottery and has since drawn to my attention the forms of handles of the Plum tradition of New Caledonia which has been dated to the beginning of the first millennium AD (Sand 1995:120–123, 1998:19). These handles include 'boutons' very similar in form to the Malau phallic handles. Some of these 'boutons' were decorated either with rows of dots in the form of a star or by dots in no apparent order. No phallus-shaped handle found on Vanua Levu has yet shown any form of decoration, but one from Sigatoka which I saw in a private collection (now lost) had lines incised round the waist. Any cultural relationship between the Malau handles and the other handles referred to must, however, remain indeterminate until the Malau handles can be positively dated. Somewhat similarly shaped handles have been found by Solheim (1965) and Harrisson (1968) in Sarawak, and by Bellwood (1978) at Kupang, Brunei, which may date from AD 1000 or later.

Although two phallus-shaped handles of covers of vessels have been reported from elsewhere in Fiji, this is the first report of such handles being found on Vanua Levu and in such relatively large numbers, especially at Malau. If further investigations indicate that these phallus-shaped handles are of a later period than that of the Lapita ceramics, I would venture to suggest that it would be appropriate to refer to such a period as the Malau period, in recognition of the type-site. Assuming that these are in fact the handles of covers and not pot stands, there is no evidence at present for the form of vessel of which they are probably covers.

If contemporary with dentate-stamped decoration and carinated bowls of the Lapita period, the question arises as to whether the Malau ceramics may, in some practical way not at present apparent, complement the other recognised types of Lapita ceramics. For instance, if the missing vessel from Malau was indeed a cinerary urn contemporary with the covers, it is tempting to raise the question as to whether the Malau evidence is for cinerary urns and for the practice of cremation on Vanua Levu at a time when inhumation was practised elsewhere (e.g. Natunuku).

The other forms of handle are noteworthy, if only because they occur in such large numbers and thus present a special feature of the Macuata pottery. Of particular interest are the hexagonal form of handle and the vertical looped handle with incised decoration from Malau. I have been unsuccessful in determining whether similar features have been found elsewhere in Fiji or the neighbouring territories, but both warrant further investigation. The hexagonal handle, if not some of the others, may be contemporary with the phallus-shaped handles.

Future directions

Following these preliminary investigations at the three sites on the island of Vanua Levu, and the discovery of such a variety of ceramics, it is intended that further controlled investigations, including perhaps excavation, should be undertaken at Malau and Vaturekuka, and perhaps at Buaqoli and other sites on the island. The aim should be to determine the relative stratification and association of these various types of ceramics, including dentate-stamped wares and carinated bowls of the Lapita period, with each other and with any other diagnostic artefacts such as adzes. It would also be hoped that some firm evidence may be found for the positive dating of these ceramics and associated artefacts, and for any structural features of the sites where they are found. Another line of investigation that should be undertaken is to determine the coastline in the Vaturekuka / Labasa area during the Lapita period.

Knowledge of the nature of the temper sands contained in the ceramics of Vanua Levu is meagre in the extreme. It appears to be limited to the results of the examination, on my request, by William Dickinson of two sherds from Malau and Vaturekuka. His finding (Dickinson 1997) was that there was "no reason to suppose that either of the sherds were made anywhere other than central Vanua Levu, and each could well have been made close to its site of recovery. Although the proportion of grain types are different in the two sherds, the same array of grain types occur in both sherds, and can be considered provisionally as typical of central Vanua Levu tempers". It is hoped that Dickinson will be able to make further studies of the ceramic tempers, which should be useful in determining the provenance of the temper sands and the place where the pottery was made.

These studies raise the question of possible prehistoric connections between those living in what is now the province of Macuata and those in territories beyond Vanua Levu. Evidence from the sites of Malau and Vaturekuka suggests possible lithic and ceramic as well as traditional connections, first, with Polynesia, perhaps Samoa, as suggested by the stone adze from Vaturekuka; and, secondly, with the island of Rotuma, some 500 km north of Macuata, where pot sherds have recently been discovered. Dickinson suggested (1997) that one of these sherds had sand temper which could have been derived from Vanua Levu. I was told both in Macuata and on Rotuma that there are also traditional connections between Macuata and Rotuma. The ceramic connection will, however, remain but an interesting possibility until more sand tempers are compared. On the other hand, the evidence of sand tempers may show that there is a ceramic connection as well as a traditional and a historical connection between Rotuma and Tonga (Dickinson 1997; Parke 1964, 2000; Shutler and Evard 1991; Shutler 1998). Preliminary studies such as these should serve as a useful basis for future investigations which it is hoped will be undertaken into these and other possible connections.

Acknowledgements

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A continuous sequence? *Trochus* shell artefacts in Lapita and post-Lapita assemblages from the Arawe Islands, West New Britain Province, Papua New Guinea

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Introduction

Worked shell is found in archaeological sites dating from the time of initial colonisation of the Pacific Islands (Smith and Allen 1999). Shell artefacts provide evidence of food collection and preparation strategies, resource use and social behaviour and are a unique record of human adaptation to island environments. Despite the recognised importance of shell-artefact distributions in constructing Pacific history, little research has been undertaken into the technology and process of shell-artefact manufacture or the means by which archaeologists identify worked shell (see Barton and White 1993; Cleghorn 1977; Smith 1991; Spennemann 1993). As a consequence, our knowledge of its distribution is limited to the easily recognised end-point of manufacture or 'ideal type' — the fish hook, the armband, the adze. Given the limits that archaeological sampling and preservation place on locating shell artefacts, identifying their 'presence' in the debitage of their manufacture potentially provides a more accurate reflection of their spatial and temporal distributions. Analogous to technological studies of stone-artefact manufacture, analysis of shell debitage is also likely to reveal expedient artefacts not currently recognised in shell artefact inventories.

This paper reports the investigation of an apparent association of particular shell-artefact types with pre-Lapita, Lapita or post-Lapita assemblages through an analysis of shell debitage recovered from midden assemblages. A reduction sequence for the manufacture of *Trochus niloticus* artefacts was identified in the debitage of shell-artefact manufacture. Although the *Trochus* fish hooks and armbands were recovered almost exclusively in association with Lapita (and pre-Lapita) and post-Lapita assemblages respectively, a similar technology and initial reduction sequence were used in the manufacture of all *Trochus* artefacts across all three phases. This blurs the type distinction but highlights the significance of the apparent loss of one-piece fish hooks from post-Lapita assemblages.

The analysed assemblages were excavated by Chris Gosden in the Arawe Islands, West New Britain Province, PNG, between 1985 and 1992, initially as part of the Lapita Homeland Project and subsequently the West New Britain Archaeological Project. The excavations of Lapita and post-Lapita ceramic and aceramic middens and the pre-Lapita deposit of Lolmo cave have been reported previously. Detailed description of the site stratigraphy and radiocarbon chronology is in Gosden (1989), Gosden and Webb (1994), Gosden et al. (1994), Specht and Gosden (1997) and Summerhayes (2000). The Arawes Lapita sites have been well dated but the time frame represented by the post-Lapita deposits is unclear. The data from post-Lapita sites discussed below may represent the entire period from the immediately post-Lapita period to the last thousand years. Shell artefacts were recovered from all Arawes sites including the pre-Lapita deposit of Lolmo Cave (see Smith 1991 for details of their provenance). The artefacts are listed in Table 1 according to type, species and context.

Table 1. Shell artefacts excavated from the Arawe Islands.

ARTEFACT TYPE	SPECIES	PORTION OF SHELL UTILISED	AGE-PRE LAPITA	AGE-LAPITA	AGE-POST LAPITA
adze	*T. gigas*	hinge		5	1
(whole and broken)		margin		2	
	T. maxima			1	4
adze preform	*T. gigas*	hinge		1	1
		margin		2	3
	T. maxima	margin		2	8
'chisel'	*Tridacna* sp.				1
point	*Tridacna* sp.		1		
disk	*Tridacna* sp.	umbo		11	2
	T. maxima			1	2
	Conus sp.	ground	1	13	2
		preform		1	1
ring (whole & broken)	*Tridacna* sp.		1	9	2
(ground)	*Conus* sp.			15	
	T. niloticus			2	26
ring preform	*T. niloticus*			3	66
(not ground)	*Conus* sp			1	
reworked artefact	*T. niloticus*			2	45
scraper	*Tridacna* sp.			10	9
fish hook	*T. niloticus*		1	8	
	Pinctada sp.			1	
fish hook blank	*T. niloticus*			6	
debitage	*T. niloticus*	base		41	39
		fragment		4	11
	Conus sp.	base		7	3
		top		9	2
		fragment		10	1
	Turbo sp.			3	
shell horn	*C. tritonis*		1		
'octopus lure'	*Cypraea* sp.	dorsum		17	2
'vegetable scraper'	*Cypraea* sp.	base		2	2
'net sinker'	bivalve			9	15

Background

Understanding change through time in early archaeological assemblages from Island Melanesia has been central to intensive archaeological research in the region over the past two decades (Kirch 1997; Spriggs 1997). A focus of this research are the artefacts and subsistence strategies associated with the appearance of Lapita ceramics in Island Melanesia, ca. 3500 BP (Specht and Gosden 1997). These new artefacts include a number of shell-artefact types consistently found in Lapita sites in Island Melanesia including shell adzes, fish hooks and ornaments including armbands and disks. Recent work on pre-Lapita Island Melanesian assemblages indicates that at least some of these types were present in the region prior to the appearance of Lapita ceramics. Smith and Allen (1999) discuss a range of worked shell from late-Pleistocene deposits and early-Holocene deposits on New Ireland including the debitage of *Tridacna* and *Trochus* working dating as early as 20,000 BP and a shell bead from a context dated to ca. 8000 BP. Fredrickson et. al. (1993) report the recovery of *Tridacna* shell adzes from deposits on Manus dated before 10,000 BP and from the same deposit Spriggs (1991a:309) reports the debitage of *Trochus* working as early as 8000 BP. For a recent summary of the evidence see Green (2000).

Shell artefacts from Lapita sites have both a direct functional use, such as adzes and fish hooks, and an inferred social function, such as ornaments including rings, discs and pendants. It has been suggested that these shell 'valuables' are trade items and, along with decorative motifs on ceramics and obsidian artefacts, constitute evidence for long-distance interaction of Lapita communities (Kirch 1988, 1997:237). However, unlike obsidian, shell cannot be sourced and this argument relies on evidence for the manufacture of shell ornaments being identified at one site but absent at another site where the presence of finished artefacts is considered evidence of their being brought to the island. Clear criteria for the identification of the debitage for shell-artefact manufacture are central to such an interpretation.

Research on shell-artefact assemblages from post-Lapita sites is rare although a number of authors note differences in the shell artefacts associated with Lapita and post-Lapita deposits. Kirch et al. (1991:154) noted fish hooks of *T. niloticus* and *Tridacna* sp. Adzes, made from the hinge portion of the shell, were present in Lapita assemblages from Mussau together with "a variety of rings, disks and beads" (1991:152). In the post-Lapita assemblages, *Trochus* shell armbands and *Tridacna* adzes made from the margin of the shell are common. It appears from their description of the artefact inventory that *Trochus* fish hooks are missing from the post-Lapita assemblages along with many of the shell valuables. In the Nissan sequence, Spriggs (1991b:237) reports a *Trochus* shell fish hook in his aceramic Halika phase, contemporary with Lapita elsewhere. A single *Trochus* armband was found in association with Lapita ceramics. *Trochus* armbands increase in frequency in subsequent phases. Like the Mussau assemblages, *Tridacna* hinge-region adzes are found in association with Lapita ceramics and adzes made from the dorsal region of the shell in post-Lapita assemblages.

Similar differences are evident in the representation of artefact types from Lapita and post-Lapita deposits in the Arawe Islands (see Table 1). It should be remembered that only a relatively small amount of deposit was excavated from the pre-Lapita context of Lolmo Cave and therefore the quantity of pre-Lapita artefacts is not a measure of their abundance or range relative to Lapita and post-Lapita deposits. Shell fish hooks are present only in association with Lapita ceramics and in the pre-Lapita context. Rings manufactured from the base of *Conus* sp. are also found only in association with Lapita ceramics but are absent from post-Lapita contexts, whereas rings or armbands of *T. niloticus* were recovered almost exclusively from post-Lapita deposits. Only three *Conus* sp. discs are associated with the post-Lapita whereas 14 were recovered from Lapita contexts and one pre-Lapita. Adzes and adze blanks from the Arawes Lapita sites are most frequently *T. gigas*, from the hinge region of the shell whereas those found in post-Lapita deposits are far more likely to be manufactured from the margin of *T. maxima*. Also common in Lapita deposits but rare in post-Lapita are 'discs' of the umbo of *T. gigas*, possibly used as hammer stones. Forty-five reworked *T. niloticus* artefacts were identified in post-Lapita assemblages in contrast to only two from Lapita assemblages. These are discussed below.

Given that similar differences have been noted in the shell-artefact assemblages from a number of Lapita/post-Lapita contexts, it is unlikely that the association of particular artefacts with either Lapita or post-Lapita sites in the Arawes can be explained through archaeological sampling. However, this is an association based on easily recognisable end points (or near end points) of artefact manufacture. To investigate the strength of this association, an examination of *Trochus* shell debitage was carried out. Although clear differences in the association of *Tridacna* and *Conus* artefacts with Lapita and later assemblages are apparent in the Arawe assemblages, analysis of the shell debitage was limited to *Trochus* debitage for the following reasons. Shell-artefact morphology is dependent upon the macroand micro-structure of the shell species from which it is made (see Smith 1991; Smith and Allen 1999) and therefore on raw-material availability. The availability of particular shell species can vary over time due to minor climatic and sea-level change; local environmental change such as silting of reefs due to land clearance, and human exploitation. Hinge-region adzes are manufactured from mature *T. gigas* specimens. Lack of appropriate specimens of these slow-growing shellfish may lead to the use of the smaller, faster growing *T. maxima* as a raw-material source and account for the change through time seen in adze morphology. A similar argument could be made for the absence of *Conus* rings in the post-Lapita assemblages. The rings excavated from the Arawes Lapita sites are all made from *Conus* shells far larger than the average size of *Conus* sp. now found in the Arawe Islands.

The potential effect of a change in the availability of raw material over time did not have to be taken into account in an investigation of differences in the representation of fish hooks and armbands because they are both manufactured from *Trochus niloticus*.

Methodology

During excavation of the Arawes sites, a regular breakage pattern and number of surface attributes were noted on *T. niloticus* and considered possible evidence of the shell having been worked. Two kinds of technological attribute were consistently observed on the broken shell and identified as 'pecking' and grinding. Small, uniformly sized flake scars observed on the broken edges of many artefacts give them a look of having been 'pecked'. These flake scars vary in their size between artefacts but are usually consistent on each artefact and are usually initiated from the outer surface of the shell. They vary in the regularity of their spacing around the edge of the shell, giving the artefacts anything from a roughly hewn to a carefully shaped appearance. In the analysis of *Trochus* debitage, the presence of 'pecking', the position on the artefact and uniformity (regularity) of the flake scars were noted.

Some artefacts appear to have been at least partially ground. Striations resulting from the grinding process were visible on many of the artefacts with the naked eye or under low power magnification.

All the *Trochus* artefacts were manufactured from the terminal whorl and include the thick, relatively flat base of the shell (Figs. 2–3). The method of removal of the terminal whorl from the body of the shell (Fig. 1: Stage 1) is unknown, however this process leaves a characteristic 'pecked' edge on the wall of the shell. A debitage of fragments from the upper whorls and the spine of the shell results.

Armband manufacture

Following removal of the terminal whorl from the body of the shell, the base of the shell, including the growing edge of the terminal whorl, is removed, leaving a ring shape with 'pecking' along the broken edges. The ring is further reduced (Fig. 4), the flake scars ('pecking') are more regularly spaced (Fig. 1: Stage 2). In this way all remains of the base and wall of the shell are removed to leave a ring of roughly triangular cross-section. Grinding, initially on the upper and lower surfaces, is then used to shape the artefact (Fig. 1: Stage 3), obscuring the 'pecking' marks. Finally, the remaining outside surface of the shell is ground, removing, at least partially, the exterior surface, its colour and pattern (Fig. 1: Stage 4).

Fish hook manufacture

Following removal of the terminal whorl from the body of the shell a triangular shape including the outer edge of the shell is removed from the base. Similarly to the armbands, it is unclear how this is achieved. 'Pecking' is usually evident on the edge of these tabs where the body of the shell has been removed. One other side of the triangle has the appearance of having been intentionally 'cut' or sawn perpendicular to the grain of the shell structure that usually governs the angle of breakage (Fig. 4). These triangular fragments or tabs are uniform in their size and shape and are identified as fish hook blanks or tabs (Fig. 1: Stage 5).

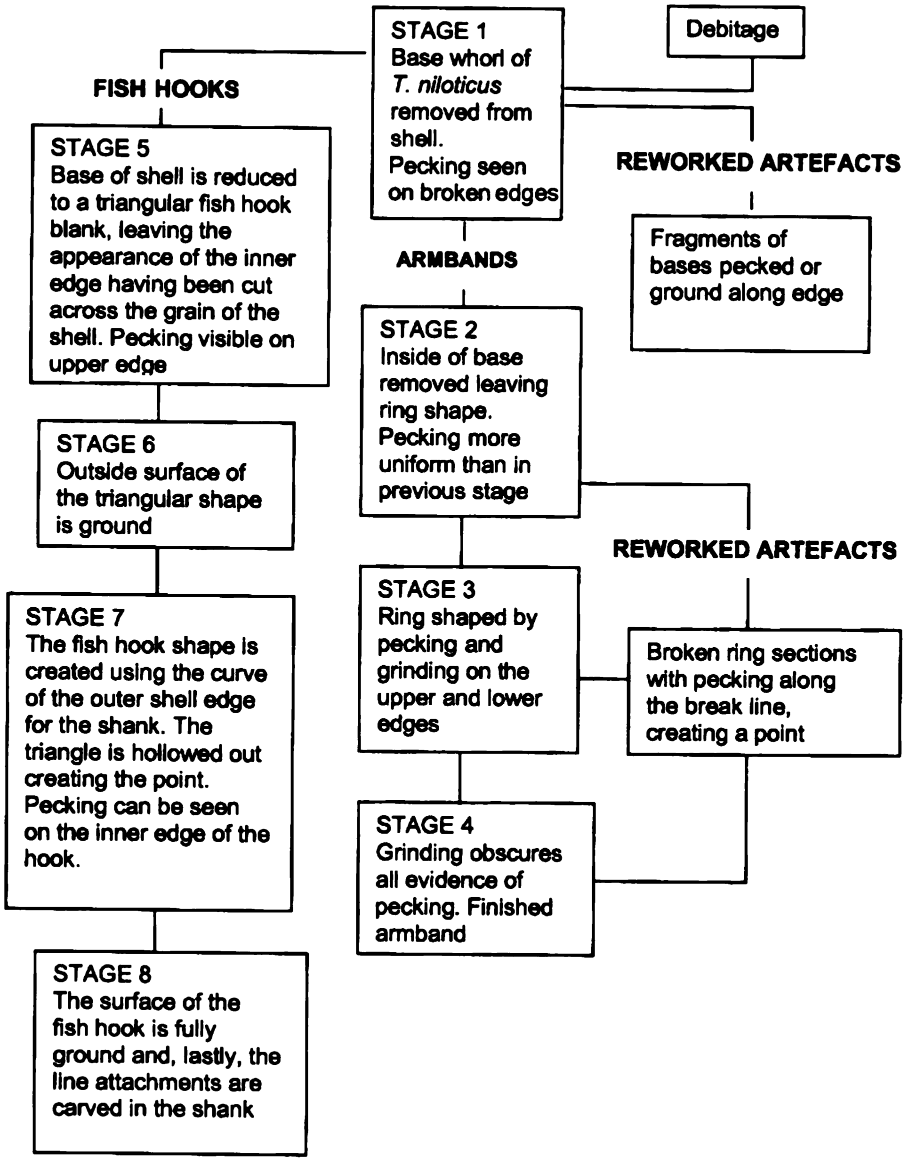

Fig. 1. A reduction sequence for the manufacture of *Trochus* artefacts from the Arawe Islands.

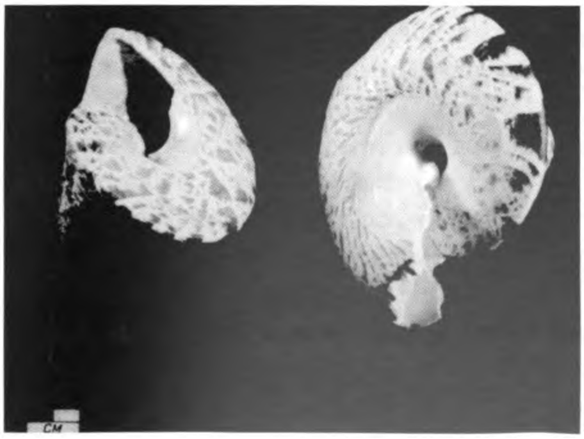

Fig. 2. *Trochus niloticus.*

Fig. 3. The terminal whorl of *T. niloticus* with the body of the shell removed. Note 'pecking' along broken edges.

Fig. 4. Stages 2 to 3 of armband manufacture. Grinding has begun to obscure 'pecking'. Note ground point of artefact to the left.

Fig. 5. Stages 5 (L) and 7 (R) of fish hook manufacture. Note 'cut' edge at the top of fish hook blank (L).

Fig. 6. Reworked *Trochus* debitage. Note ground end of artefact.

The slightly convex outer surface of the tabs is then ground flat, removing the surface pattern of the shell except the curved outer edge (Fig. 1: Stage 6). The curving outer edge of the shell provides the shape of the fish hook after removal of the softer fabric of the original shell's interior surface. The removal of this material is probably achieved through a combination of 'pecking' and grinding but only two specimens at this stage of reduction were recovered, which was not sufficient to investigate this further (Fig. 1: Stage 7). Once this softer fabric is removed, the fish hook is ground (Fig. 5). This rounds the shape of the shank and point. The point is sharpened and the line attachments carved into the top of the shank (Fig. 1: Stage 8). All fish hooks in the assemblage appear to be unfinished and are likely to have been discarded after breaking during manufacture.

Reworked artefacts

During the analysis a number of artefacts at different stages in the reduction sequence were observed to differ from the expected pattern both in their technological attributes and in the position of the attributes on the artefact. These are the 'reworked' artefacts described in Fig. 1. Grinding is more usual at a later stage in the reduction of shell than 'pecking', however five base fragments (Stage 1) had been partially ground at one end (Fig. 6). It is unclear whether the grinding is intentional or the result of use wear. On 42 artefacts at Stages 1, 2 and 3, 'pecking' was observed on the broken edge of the artefacts, usually ring segments, shaping it to a point (see Fig. 4).

It appears that the debitage of armband and possibly fish hook manufacture was occasionally used as tools and also reworked. It is also possible that these artefacts are the result of a reduction system specifically aimed at their manufacture, especially given their frequency. The ring segments shaped to a point at one end are identical to the point on a trolling lure made of *Trochus* shell with a wooden shank, observed in the anthropological collection of the Otago Museum in Dunedin, New Zealand, provenanced to Island Melanesia.

Although the method of manufacture of *Trochus* shell artefacts from archaeological contexts cannot be discerned from the archaeological evidence, ethnographic observation offers some insight. During the 1991 field season, women of the Arawe Islands were observed manufacturing *Trochus* armbands from the terminal whorl. These are still used as ornaments and are highly valued. In the first stage of manufacture, the terminal whorl was removed from the body of the shell by holding a piece of smouldering coconut shell to the join between the terminal and penultimate whorl. The coconut shell is held at intervals around the whorl, weakening the shell structure. Once this is achieved, pliers are used to break the shell along the line and remove the terminal whorl. The same procedure is used to remove the inner part of the base of the shell, creating a ring that is then narrowed by further removal of fragments with the pliers. The remaining ring is ground using a large flat stone at the centre of the village. Obviously metal tools were unavailable for manufacture of the excavated artefacts but the technique of using heat to weaken the shell at a specific point could easily have been employed in the early stage of their manufacture.

Discussion

The categorisation of the *Trochus* artefacts according to technological attributes and their position on the shell enabled a generalised reduction sequence for the well-known *Trochus* artefacts of armbands and fish hooks to be identified. The sequence is similar to begin with, diverging as the artefacts take on their functional shape. The analysis also resulted in the identification of expedient tools and perhaps the deliberate manufacture of trolling lures, previously unrecognised in Arawes archaeological deposits.

These findings have two major implications for analyses of shell artefacts in general. Firstly, continuity in the technology of manufacture of the *Trochus* artefacts blurs chronological phases that may be inferred from the presence or absence of artefact types or their association with particular kinds of assemblages. The absence of one-piece *Trochus* fish hooks in post-Lapita deposits in the Arawes appears to be a 'real' absence because it can now be argued on the basis of the reduction sequence that no debitage can definitely be associated with their manufacture. In light of this, the disappearance of *Trochus* fish hooks from the Arawes sequence becomes a significant behavioural question. The presence of what appear to be *Trochus* points for trolling lures in the post-Lapita suggests a shift in fishing strategy. Secondly, the identification of reworked and new artefact types supports a number of previous claims (see Smith and Allen 1999) for expedient shell artefacts being present, but unrecognised, in midden assemblages in general, but in particular in early assemblages from Island Melanesia. These artefacts offer a potentially important but under-investigated body of knowledge about the early colonisation of island environments.

How are we to interpret similarities and differences in the shell-artefact assemblages from late Pleistocene and Holocene Island Melanesian assemblages? Green has recently argued that there is insufficient evidence — both in the range of formal artefact types and in the overall quantity of artefacts recovered from pre-Lapita contexts — to argue that there is continuity from pre-Lapita to Lapita shell technology in the Bismarck Archipelago (Green 2000:380). One difficulty with pre-Lapita/Lapita comparisons in general and specifically Green's comparison of the quantity of shell artefacts recovered from pre-Lapita and Lapita contexts in the Arawe Islands is sample size. Many cubic metres of deposit containing Lapita and post-Lapita ceramics were excavated from the site in the Arawe Islands (see Summerhayes 2000), but the pre-Lapita deposits from Lolmo Cave were no more than a single cubic metre. This aside, the technological approach to investigating shell artefacts presented here and by Smith and Allen (1999) suggests that inferences based solely on the presence of formal artefact types is inadequate as an assessment of continuity and discontinuity. As this analysis of *Trochus* working demonstrates, when using a combination of approaches, morphological, functional, technological, differences and similarities between the assemblages take on a significance not evident in a single approach and not easily explainable in cultural terms.

Although I agree with Green (2000) that our evidence for pre-Lapita shell working is limited, there is now good evidence that *Trochus niloticus* and other shell, including *Tridacna* sp. and *Turbo* sp. were being used as raw material in shell-artefact manufacture from as early as the late Pleistocene, ca. 20,000 years ago (Smith 1997). *Trochus* shell armbands continue to be manufactured in the Arawe Islands and elsewhere to this day. While this alone is cause for consideration it also appears that a similar technology for reduction of the shell, which utilises the morphology and microstructure of the shell, has been in use for a very long time. Against this backdrop, the findings presented in this paper make a small contribution towards exploring the significance of shell artefacts in the Pacific archaeological record.

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The reef, the beach and the rocks: An environmental analysis of mollusc remains from Natunuku, Viti Levu, Fiji

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Introduction

The coral-reef environment has been the focus of much attention in terms of shellfishing, and the term 'reef exploitation' has, at times, been used synonymously with the practice of shellfish gathering (e.g. Groube 1971; see also Swadling 1996). Coral reefs are typically highly productive areas (Kirch and Hunt 1997:119), and thus profitable zones for foraging and fishing. They are, however, only one of a number of common coastal zones — especially where larger 'continental' islands such as Viti Levu are concerned. Other coastal zones, such as mud-flat, estuarine and sandy intertidal habitats, can also be extremely productive when gauged in terms of biomass. When site location and accessibility of marine habitats are considered, reef exploitation may indeed be demonstrably less effective than exploiting local resources from other productive zones. For this reason, this paper seeks to offer an alternative view to that which contests that shellfish assemblages in which the coral-reef component is negligible are idiosyncratic, less efficient, or "atypical" of Lapita (Green 1979). Furthermore, it asks whether one can speak at all of a typically Lapita gathering strategy.

On larger continental Pacific islands there is a diverse array of environments that harbour shellfish, including estuaries, freshwater environments and sandy and rocky shores, as well as coral reefs. All of these environments contain different communities of species in varying densities. The site of Natunuku (VL1/1) in Fiji presents an interesting test case for Lapita gathering strategies in that a range of coastal environments are all located in close, or relatively close, proximity to the site. Given the location of Natunuku, it is a highly suitable site to ask how important coral-reef species are relative to species from closer soft shore beds and rocky outcrops. Put another way, the mollusc assemblage from Natunuku can provide insights into what Lapita collectors looked for in their shellfish.

Background

The site of Natunuku is located on the northern coast of Viti Levu, just east of the mouth of the Mba River (Fig. 1). The river mouth creates brackish and estuarine environments replete with

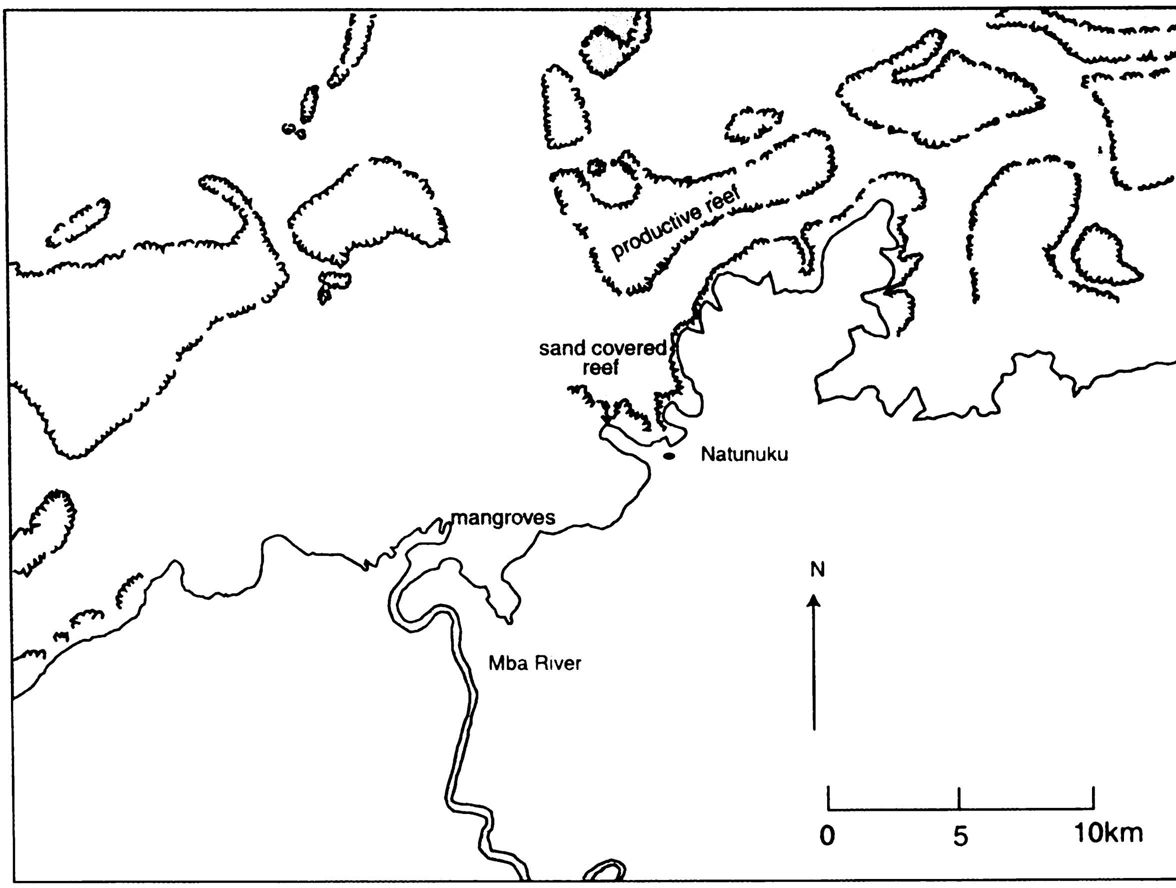

Fig. 1. Map of the north coast of Viti Levu, Fiji, showing the location of Natunuku and littoral environments in the vicinity.

well-developed stands of mangroves. Adjacent to the site itself is a sand-covered reef, though the nearest productive reef is approximately 3 km offshore. Also present are scattered rocky outcrops. Since each of these environments contains different communities of species, the species present in the midden can tell us which areas were being exploited for the gathering of shells for food and raw materials.

Unfortunately, Natunuku is a disturbed site, so questions regarding change over time cannot feasibly be addressed (see Anderson and Clark 1999 for a discussion of the Natunuku radiocarbon dates). Upon saying this, however, the homogeneity throughout the sample of taxa present and the proportions in which they are present, would suggest that major changes in species collected and general taxa availability over time have not changed greatly. The relative stability of environmental conditions in the Natunuku area over time is attested to by a palaeo-environmental analysis presented by Nunn (1998:67, 76) with the only major change being a gradual building up of silt which offsets emergence in the area. This would have served to steadily expand habitats for soft-shore taxa with a tolerance for silty sand.

A total of 58,235 g of shell was excavated from three locations in the site during investigations in 1996 directed by Atholl Anderson (Australian National University) and Christine Burke (Fiji Museum). The sample was dry-screened through 4 mm mesh. The entire sample was then identified to the lowest taxonomic level possible and then quantified using both minimum numbers (MNI) and number of identified specimens (NISP) as well as weights. For an in-depth discussion of methodology, as well as full data, refer to Szabó (n.d.).

Given that Lapita molluscan assemblages containing predominantly intertidal bivalves have been characterised as "atypical" (Green 1979:35), we must first establish what we would expect a 'typical' assemblage to look like. One way of doing this is to hypothesise the most efficient gathering strategy based on the location of the site and resource availability in the surrounding area (e.g.

Anderson 1981; Szabó 1999). Such an approach is offered by optimal-foraging theory, which is based on the premise that to maximise reproductive fitness, the forager must obtain the greatest amount of energy in relation to the amount of energy expended. In terms of shellfishing, this translates to the targeting of high biomass ecological niches — generally densely packed beds of gregarious species. In addition, these resources should be located in close proximity to the base site so as to minimise the expenditure of energy in relation to time and distance.

As discussed, Natunuku lies close to fresh water, brackish estuarine, sandy intertidal and rocky shore environments, with the closest productive coral reef being 3 km offshore. As outlined above, there have been few major environmental changes along the northeast coast of Viti Levu over the last 3000 years, excepting a gradual accumulation of silt around the mouth of the Mba. It is thus hypothesised that the mollusc assemblage from Natunuku will contain shellfish remains from the four closest environments rather than the coral reef. Moreover, we should see a predominance of gregarious, easily collected species.

Results of analysis

In total, 88 species were identified, as well as 32 taxa identified to genus, 11 taxa identified to family, and one taxon identified to sub-class (Polyplacophora). The 20 most numerous taxa as calculated through MNI (minimum number of individuals) and weight are graphed in Figs 2 and 3 respectively. Table 1 shows the environmental zones inhabited by the 20 most abundant taxa.

In agreement with the model projected for shellfish gathering strategies at Natunuku, Figs 2 and 3 show that the assemblage is dominated by the soft-shore intertidal bivalves *Anadara antiquata* and *Gafrarium tumidum*. These are both colonial species that aggregate in dense beds. This tendency makes collecting profitable, as many specimens can be collected in a short time within a limited area. The same can be said of the oyster *Saccostrea cucullata* which grows in closely packed sheets or clusters. All three species inhabit environments close to Natunuku.

Other prominent species such as *Chama pacifica, Planaxis sulcatus* and the various *Nerita* species (nine species of marine neritids in all) are also gregarious. The latter two taxa, as well as *Turbo cinereus*, are upper intertidal dwellers, and, being exposed and clearly visible, are easy targets for quick collection. Unfortunately, the paucity of literature on *Batissa violacea* prevents much discussion, however the work of Meehan (1982:64) suggests that this species is also colonial.

The above-mentioned species appear to be targeted prey species. They are either represented in large numbers relative to the sample size, or are the major species represented from a particular coastal zone. Thus, although species such as *Turbo cinereus* and the various species of marine neritid are represented in considerably lower numbers than *Anadara antiquata* and *Gafrarium tumidum*, they are among the major taxa represented from the rocky upper intertidal zone.

Where a species is represented in significant rather than high numbers, and shares an ecological niche with a species that is a target prey species, it is regarded here as a secondary species. This means that, although the species itself is not a predetermined target, if encountered it will be collected. Secondary species represented in the Natunuku assemblage include non-colonial species such as *Lambis lambis, Polinices tumidus, Polinices flemingiana* and *Chicoreus torrefactus*. Also included are colonial species that do not occur in extensive beds in the area such as *Periglypta puerpera, Pitar pellucidus, Atactodea striata* and *Gafrarium pectinatum*.

In addition to targeted prey species and secondary species, there are also incidental species. It is important to remember that for a species to be classified as incidental, it must be incidental *to* something else — either another species of shell, or other collected material such as seaweed or coral. Examples of incidental species from Figs 2 and 3 are the ceriths *Clypeomorus traillii* and *Cerithium columna*. Specimens of both species are small and show no breakage patterns that would suggest meat extraction. Species of the

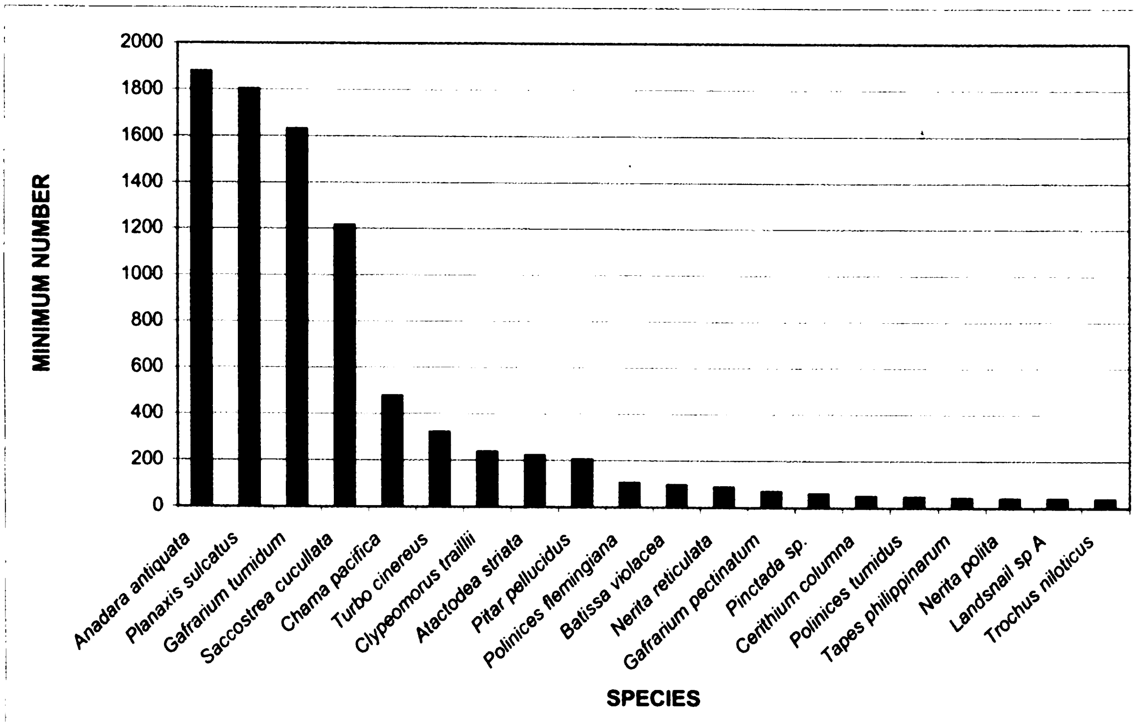

Fig. 2. Histogram to show the 20 most important shellfish taxa at Natunuku as calculated through minimum numbers.

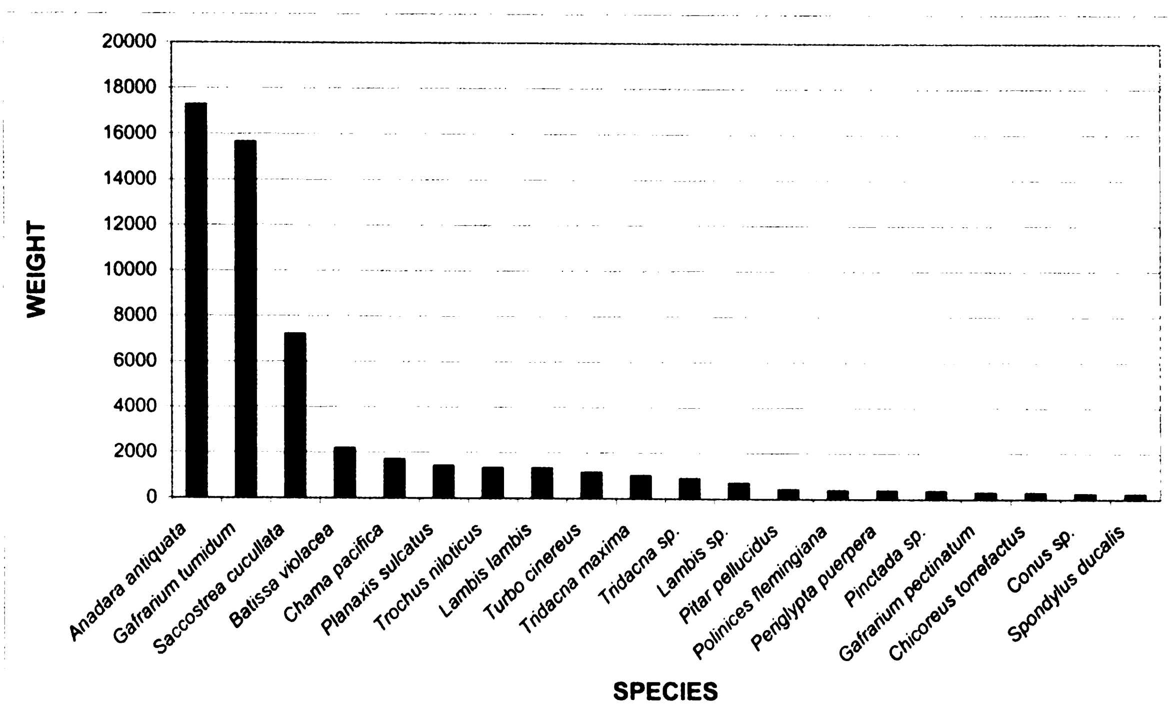

Fig. 3. Histogram to show the 20 most important shellfish taxa at Natunuku as calculated through weights.

genus *Cerithium* and *Clypeomorus* are intertidal molluscs that live in clean to weedy sand (Cernohorsky 1972:62). It is suggested, then, that specimens of *Cerithium columna* were collected incidentally when gathering burrowing sandy intertidal species such as *Anadara antiquata* or seaweed.

The species that stands out as being anomalous in both Figs 2 and 3 is the gastropod *Planaxis sulcatus*. As stated in Table 1, *Planaxis sulcatus* occurs in clusters in exposed positions on upper intertidal

Table 1. Major species and their environments identified for Natunuku.

FAMILY	SPECIES	ENVIRONMENT INHABITED	REFERENCE
Trochidae	*Trochus niloticus*	Exposed sides of reefs	Coleman 1981:171
Turbinidae	*Turbo cinereus*	Found locally on intertidal rocks around the high-water mark	Coleman 1981:97 Cernohorsky 1972:46
Neritidae	*Nerita reticulata*	Intertidal rocks around high-water mark	Cernohorsky 1972:48
	Nerita polita	Intertidal rocks around high-water mark	Cernohorsky 1972:48
Planaxidae	*Planaxis sulcatus*	Found in clusters on exposed rocks around high-water mark	Coleman 1981:160 Cernohorsky 1972:58
Cerithidae	*Cerithium columna*	Shallow intertidal sand	Cernohorsky 1972:62
	Clypeomorus traillii	Sand-covered rock	Cernohorsky 1972:62
Strombidae	*Lambis lambis*	Reef flats and rubble patches or sand	Coleman 1981:230 Cernohorsky 1972:84
Naticidae	*Polinices flemingiana*	Sand bars and beaches	Cernohorsky 1972:98
	Polinices tumidus	Intertidal and subtidal sand patches	Coleman 1981:217
Muricidae	*Chicoreus torrefactus*	Intertidal and subtidal under rocks and coral slabs	Coleman 1981:150
Arcidae	*Anadara antiquata*	Intertidal coral sand; some tolerance for mud	Cernohorsky 1972:216 Abbot 1982:54
Pteriidae	*Pinctada* sp.	Intertidal and subtidal	Cernohorsky 1978:177-8
Spondylidae	*Spondylus ducalis*	Intertidal, attached to rocks or coral	Cernohorsky 1972:218
Ostreidae	*Saccostrea cucullata*	Sheltered rocky shores and mangroves, mid-intertidal	Edgar 2000:295, Cernohorsky 1978:182 Coleman 1981:31*
Chamidae	*Chama pacifica*	Intertidal and subtidal rocks	Cernohorsky 1978:183
Tridacnidae	*Tridacna maxima*	Partially embedded in coral	Coleman 1981:168
Mesodesmat-idae	*Atactodea striata.*	Intertidal sand	Abbot and Dance 1982:339
Corbiculidae	*Batissa violacea*	Freshwater	Abbot and Dance 1982:352
Veneridae	*Gafrarium tumidum*	Estuarine/brackish muddy sand flats, often associated with mangroves	Cernohorsky 1972:233 Abbot 1982:54
	Gafrarium pectinatum	Estuarine/brackish muddy sand, often associated with mangroves	Cernohorsky 1972:233 Abbot 1982:54
	Pitar pellucidus	Generally subtidal in sand	Cernohorsky 1972:233, 236
	Tapes philippinarum	Intertidal sand	Abbot and Dance 1982:365
	Periglypta puerpera	Intertidal muddy sand	Cernohorsky 1972:233

* Edgar (2000:295) discusses the species *Saccostrea glomerata*, which was formerly named *Saccostrea commercialis*. He notes that this taxonomic change has been made in recognition of the fact that the Australian *Saccostrea commercialis* is the same as the New Zealand species *Saccostrea glomerata*. The New Zealand species, however, has recently been reclassified as *Saccostrea cucullata*, thereby acknowledging its synonymity with the Indo-Pacific species (Spencer and Willan 1995). Thus, it appears that all three names refer to the same species.

rocks. Although Cernohorsky (1972:58) records this species as growing up to 30 mm in height, this size was exceptional for Natunuku, with most species only attaining a height of between 1 cm and 2 cm. Preferring exposed positions, it is unlikely to have entered the site with material such as seaweed, and the only other taxa that share its particular ecological niche are the neritids and patellids (limpets) — neither of which are substantially larger than *P. sulcatus*. Thus, it cannot be considered an incidental species. Neither does it appear to be a secondary species, as it is the dominant taxon representing the upper intertidal rocky shore. It would seem, then, that despite its small size, *Planaxis sulcatus* was targeted for collection.

Despite *Planaxis sulcatus* being a gregarious, visible, easily accessible species, its small size means that much energy is expended by the collector in return for relatively little energetic gain. One way to decrease energy expenditure, so as to maximise economic return, is to process the molluscs together rather than individually. Thus, instead of extracting the meat from every shell, it is more time and energy efficient, for example, to stew all the shells together without extracting the meat. This method of processing shells has been recorded for New Zealand, where the resulting liquid was considered a "desirable beverage" (Best 1929:77). The fact that the vast majority of the *Planaxis sulcatus* specimens are whole, agrees with this hypothesis. Moreover, given the small size of many of the *Nerita* spp. specimens, it is possible that they were processed in the same manner.

Discussion

When the ecological breakdown of the entire Natunuku assemblage is viewed (see Figs 4 and 5), it can be seen that the soft-shore intertidal zone and the rocky shore predominate. Coral-reef species make up only 1% by minimum number and 6% by weight. The three major coral-reef taxa represented are *Tridacna maxima*, *Tridacna* spp. and *Trochus niloticus*, and it is the heavy and robust nature of these taxa that accounts for the higher proportion of coral-reef shellfish when assessed through weight (Fig. 5).

When the coral-reef component is compared to the assemblages representing other coastal niches, a marked difference can be seen. The rocky intertidal and soft-shore intertidal assemblages present us with a fine-grained spread of taxa. This means that the species found in the midden are a reflection of the species found in the natural environment in the proportions that they are found in the natural environment. Thus, large beds of *Anadara antiquata* and *Gafrarium tumidum* in the natural environment close to Natunuku are shadowed by large amounts of the same species in the midden. Carnivorous and scavenging taxa such as *Chicoreus torrefactus*, *Polinices* spp. and *Nassarius* spp. are less well represented in the midden, as they occur in fewer numbers in the natural environment. In comparison, the coral-reef component of the assemblage cannot be viewed as fine-grained. The coral reef as a niche is represented nearly exclusively by *Tridacna maxima*, *Tridacna* spp. and *Trochus niloticus*. Other coral-reef shells in the assemblage include one juvenile *Turbo argyrostomus*, one juvenile *Turbo chrysostomus*, three *Trochus maculatus*, three *Trochus histrio*, two *Pyrene* sp. and one *Tectus pyramis*. It is possible that some of the *Conus* sp. represented are also reef-dwelling, however specimens are too bleached to identify to species and thus environment. Considering the diversity and richness of coral-reef molluscan fauna, the reef component of the Natunuku mollusc assemblage cannot be considered fine-grained. Rather, we see a near-exclusive focus on *Tridacna maxima*, *Tridacna* spp. and *Trochus niloticus*.

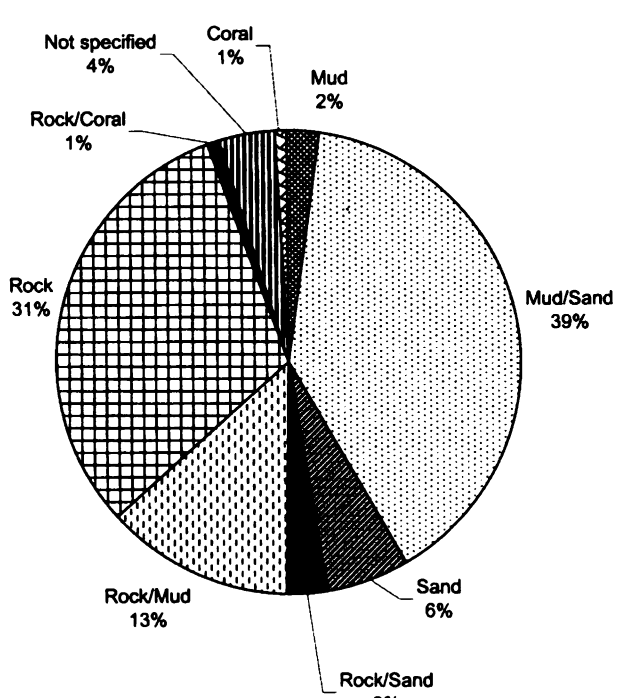

Fig. 4. Proportions of littoral habitats exploited at Natunuku as calculated through minimum numbers.

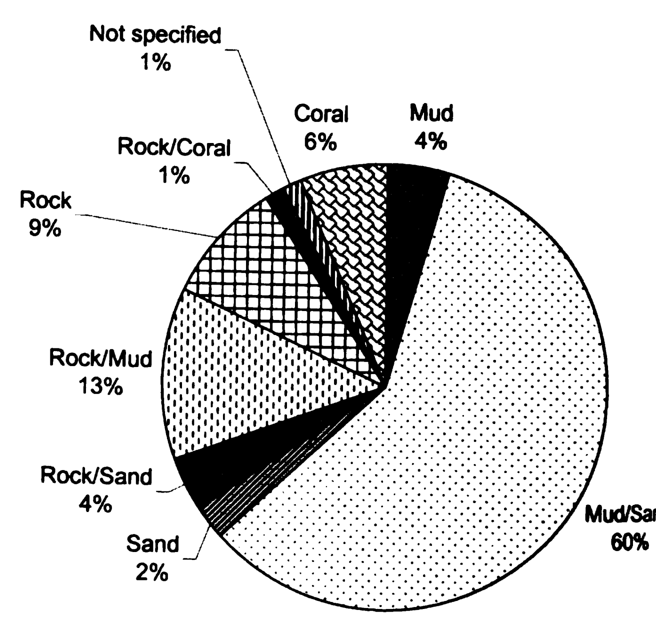

Fig. 5. Proportions of littoral habitats exploited at Natunuku as calculated through weights.

The reasons for the difference between the coral reef and other components of the assemblage become clearer when we investigate fragmentation. The molluscan remains from the rocky and soft-shore zones generally exhibit little breakage, excepting specimens from the families Pteriidae and Isognomonidae (pearl oysters), specimens of the species *Lambis lambis* and the taxa identified as *Lambis* sp. Conversely, the *Tridacna* spp. and *Trochus niloticus* specimens are heavily fragmented. The high level of fragmentation seen in *Lambis lambis* and *Lambis* sp. most likely represents meat extraction, however it is suggested that extensive breakage in the other taxa is the debitage of shell-artefact manufacture. Although further analysis has not been carried out to investigate this possibility, the consistent morphology of the debitage as well as clearly visible flaking on some specimens strongly supports this argument.

It is very difficult to determine what the *Tridacna* spp. and *Trochus niloticus* were being made into, as no preforms or finished artefacts of these materials have been identified in the Natunuku assemblage. It appears, however, that reef molluscs were being targeted specifically for artefact manufacture, with their food value being secondary if not completely insignificant. The same point can be applied to clearly worked specimens from the pearl-oyster families Pteriidae and Isognomonidae.

Conclusion

Using the biological baseline for behaviour established through the use of optimal foraging theory, a 'typical' Lapita assemblage for the site of Natunuku has been hypothesised. In agreement with the hypothesised model, it has been shown that the residents of Natunuku were exploiting gregarious species from local environments. In this way, energetic returns were maximised. However, in addition to the predicted material, there was also a small component of the assemblage that was gathered from a coral-reef environment. Unlike the fine-grained soft-shore and rocky-shore components, the reef component focused nearly exclusively on three taxa: namely *Tridacna maxima*, *Tridacna* spp. and *Trochus niloticus*. Consistent breakage patterns, heavy fragmentation and evidence of flaking suggest that these taxa were used as raw materials for artefact manufacture. Their status as a food source remains questionable.

When the analysis of mollusc remains is placed within the context of the environment surrounding the site, it becomes clear that one cannot speak of a 'typical' Lapita mollusc assemblage. Rather, the contents will depend on available resources and their relative proximity to the site. Although availability of marine resources may be a factor in selecting a site location, this need not necessarily be a reef, especially where dense high biomass beds of soft-shore bivalves are present. For this reason, it seems that one cannot speak of a specifically 'Lapita' way of shellfish gathering. Gatherers everywhere tend to make efficient use of local resources, and there appears to be no reason to suspect that Lapita gatherers were different. What does stand out, however, is the fact that the residents of Natunuku would make the effort to procure *Tridacna* spp. and *Trochus niloticus* for reasons other than, or in addition to, subsistence. It is perhaps this characteristic, rather than generic 'reef exploitation', that may turn out to be a defining feature of Lapita gathering.

Acknowledgements

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Genetic affinities of the principal human lineages in the Pacific

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Introduction

The Lapita culture, originally defined by a characteristic type of pottery, is the most widespread cultural horizon in Oceania, spanning from the Admiralties in the west, to Fiji, Tonga and Samoa in the east (Spriggs 1995). Archaeological evidence suggests that the Lapita people were the first humans to reach Fiji, Tonga and Samoa, and probably also New Caledonia and Vanuatu. The Lapita culture is thought to have been introduced into the Pacific from Island Southeast Asia by Austronesian-language speakers (see, for example, Bellwood 1995).

In 1988, Jared Diamond, a physiologist at the University of California Medical School in Los Angeles, popularised the phrase "Express train to Polynesia" among biologists. In this model: "the Lapita must have covered 4500 km of unexplored ocean and islands separating the Bismarcks from Samoa in a mere few centuries or less", after the arrival of the 'full-blown' Lapita culture from Southeast Asia. The Polynesian culture is said to have developed in the islands around Samoa and Tonga from a Lapita precursor (Diamond 1988). Although even a cursory glance at the contributions to the present volume would indicate that the Lapita culture is a multifaceted concept, and intensely debated by prehistorians, many biologists have adopted a narrow version of the Lapita/Austronesian/Polynesian package to help interpret genetic data. It is not unusual to find terms borrowed from archaeology or linguistics to denote genetic traits, even DNA sequences, in the biological literature.

The settlement of the Pacific was the subject of study by geneticists well before the development of DNA-based techniques (see Hill and Serjeantson 1989), but the number of studies has multiplied in recent years. There are several reasons for this. Oceania includes regions with a long history of human occupation, like Australia and New Guinea, and also archipelagos settled for the first time in the last millennium. Polynesia, due to its comparative homogeneity and recent settlement history, is frequently considered a good system to test models of human migration and expansion. Blood and DNA samples, collected by medical researchers as part of disease studies, are sometimes used in population and evolutionary projects that were not envisaged when the samples were originally collected. As molecular biology techniques develop, and it becomes easier and faster to generate molecular information from DNA samples, the number and scope of the studies have multiplied.

Mitochondrial DNA variation in the Pacific

In recent years there have been several genetic surveys on human populations based on one particular marker, mitochondrial DNA (mtDNA). In contrast to the bulk of human DNA, which is found in 23 pairs of chromosomes in the cell nucleus, mitochondrial DNA is present in the cell's cytoplasm, in small organelles called mitochondria, involved in the energy metabolism of the cell. MtDNA is used in evolutionary studies because it has a number of useful features, including a simple organisation, small size, rapid rate of evolution, and uniparental (maternal) inheritance. MtDNA has been used to shed light on the evolution of *Homo sapiens* (Cann et al. 1987) and in studies of ancient DNA, for example in the recent analysis of DNA extracted from the skeletal remains of ancient Australians (Adcock et al. 2001).

One of the first anthropologically useful DNA markers to be used in Pacific studies is a harmless mutation consisting of a deletion of nine nucleotides (the DNA building blocks) from a tandem repeat in mtDNA (Wrischnik et al. 1987). This mutation is known as the nine base pair (9-bp) deletion, or sometimes as the COII/tRNA^{Lys} intergenic 9-base pair deletion, as it occurs in the space between two mtDNA genes, the cytochrome oxidase II and lysine transfer RNA genes. The mutation was shown to be present in a proportion of people of Asian origin, including Native Americans. The mutation was observed at a moderate frequency in populations on the coast of New Guinea (ca. 10–40%), and in virtually all Polynesians, whereas it was absent or rare in New Guinea highlanders. (Hertzberg et al. 1989; Stoneking and Wilson 1989). This suggested that the 9-bp deletion might be useful for tracing Polynesian origins. Moreover, the fixation of the 9-bp deletion, a characteristic Asian marker, in Polynesia, seemed to indicate that the proto-Polynesians expanded quickly from Asia into the Pacific, with little contact with the earlier settlers of Melanesia. This is consistent with the express train scenario.

Not all scholars have given wholehearted support to the express train hypothesis, on different grounds. Authors such as Terrell (1986, 1989) argue that the Lapita culture arose in Melanesia. Genetic studies based on globin gene polymorphisms indicate that Melanesian people made a significant contribution to the Polynesian gene pool (O'Shaughnessy et al. 1990). Human skeletal remains recovered from Lapita sites have been described as morphologically "Melanesian" (Pietrusewsky 1989a, 1989b).

In one of the earliest studies involving DNA recovered from skeletal remains, we showed that the 9-bp deletion was present in prehistoric human bones from several locations in the Pacific, including New Zealand, Hawaii and Society Islands. However, bones of Lapita to post-Lapita age, from archaeological sites including Watom, Efate and Sigatoka, did not carry the deletion (Hagelberg and Clegg 1993). We concluded, tentatively, that the Lapita complex might have been associated with people who were biologically "Melanesian". This would mean that the proto-Polynesians might not have been the first people to spread east of the Solomons, to Vanuatu and the central Pacific. Our guarded conclusions emphasised the small sample. Moreover, our results were based on the absence of Polynesian markers in Lapita skeletal remains, the oldest and most poorly preserved material in our sample of prehistoric bones, rather than the presence of a clear-cut genetic marker in the Lapita bones. We were well aware that our findings might have alternative explanations.

Nevertheless, this study was useful, as we identified a group of polymorphic markers which seemed to be characteristic of Polynesians and of no other population. These markers are nucleotide substitutions in the hypervariable non-coding region of mtDNA, in other words, changes from one DNA building block to another. Such mtDNA substitutions are abundant in humans of different populations, and occur at many different positions with respect to the published reference mtDNA sequence (Anderson et al. 1981). However, our prehistoric Polynesians, and our control group of present-day Tahitians, shared *identical* nucleotide substitutions at three positions in their mtDNA, positions 16217, 16247 and 16261, as well as the 9-bp deletion (Hagelberg and Clegg 1993). Interestingly, although not surprisingly, we later observed these same polymorphisms in prehistoric human remains from Easter Island, confirming that Polynesians had settled the island (Hagelberg et al. 1994). The extreme mtDNA sequence homogeneity in geographically widespread Polynesians suggested a sudden and recent expansion of people from a small number of founders.

Several studies on present-day Pacific peoples indicated that the 9-bp deletion and characteristic Polynesian mtDNA substitutions are found in most Polynesian peoples. Lum et al. (1994) described three major mtDNA lineages in Polynesia. Lineage I, which had the 9-bp deletion, was the principal lineage in Polynesia, and included 95% of Hawaiians, 90% of Samoans, and 100% of Tongans in their small population sample. Lineage II was present in a small proportion of Polynesians, and was thought to be common in Papua New Guinea. A single Samoan individual had a mtDNA sequence which was identified as Lineage III, tentatively linked to Indonesia. This pattern was later confirmed in a much larger survey by Sykes et al. (1995), who showed that the 9-bp deletion and associated characteristic substitution variants were found in 94% of their considerable Polynesian sample. The second mtDNA lineage, thought to have originated in Papua New Guinea, was found in 3.5% of Polynesians. They detected a third mtDNA lineage in just 4 Polynesians, a tiny proportion of their sample. These authors concluded that "the major prehistoric settlement of Polynesia was from the west and involved two or possibly three genetically distinct populations" (Sykes et al. 1995).

Melton et al. (1995) screened a total of 1037 individuals of twelve Asian populations for the presence of the 9-bp deletion. Although the deletion was not found in northern Indians, Bangladeshis and Pakistanis, it was present at various frequencies in samples of nine Southeast Asian populations. The three substitutions characteristic of the "Polynesian motif" (16217, 16247 and 16261) were found in most of the Samoans and coastal New Guineans in their survey, and also in east Indonesia. A similar mtDNA type, with two substitutions (16217 and 16261), was found in Polynesia, and also Taiwan. This, and other ancestral mtDNA types with the 9-bp deletion, were observed in the corridor through to Taiwan and east Indonesia. The same research group (Redd et al. 1995) concluded that the mutations associated with the Polynesian motif arose in an ancestral mtDNA type that originated in Asia, probably in the following evolutionary order:

1. 9-bp del. + 16189;
2. 9-bp del. + 16189 + 16217;
3. 9-bp del. + 16189 + 16217 + 16261;
4. 9-bp del. + 16189 + 16217 + 16247 + 16261 (Polynesian motif).

Based on the distribution of the different mtDNA types associated with the 9-bp deletion, and the amount of sequence variability found among people of the different mtDNA types (assuming that the amount of variability reflects antiquity), these workers concluded that their results supported the express train model of Polynesian origins. They suggested the following pattern for the evolutionary history of the 9-bp deletion in the Pacific: "the deletion arose about 58,000 (95% Confidence Interval (CI) =12,000–104,000) years ago in Asia. Approximately 27,000 (95% CI=17,000–65,000) years ago there was an initial population expansion involving the deletion that reached Indonesia but not further east. Between 900 and 23,000 years ago the substitution at position 16247 that created the Polynesian motif occurred probably in Indonesia, and there was a subsequent expansion about 5,500 (95% CI=1,300–9,600) years ago of early proto-Polynesians from Indonesia eastward" (Redd et al. 1995). Although the times at which the different substitutions were estimated to have occurred had huge confidence intervals (note the figures quoted above), the authors concluded that the Polynesian motif originated in east Indonesia, and that their expansion date for the Polynesian motif was consistent with "the accepted date of about 3500 yr ago associated with early Polynesian archaeological sites in the Fiji, Tonga, and Samoa region". These and other published data were enthusiastically endorsed by Richards et al. (1998) as conclusive proof that the birthplace of the Polynesians was in east Indonesia. However, this is at odds with both linguistic and archaeological evidence of Polynesian origins (Bellwood 1997).

Geographical distribution of the "Polynesian motif"

The origin of the Polynesians was investigated in a survey of several genetic systems, namely mtDNA, the male Y-chromosome, and HLA (human leukocyte antigens, a major genetic system involved in the immune response). We analysed variation in these three systems, in parallel, in eight different populations of Asia and the Pacific, namely China, Taiwan, Java, PNG highlands, PNG coast, New Britain, the Trobriand Islands, and Samoa (Hagelberg et al. 1999a). A specific Y-chromosome marker (at the DYS390 locus) was shown to be present in males in Polynesia, and island and coastal Melanesia, but absent in mainland and Southeast Asia, and in PNG highlanders. However, our sample of males was small and our results were inconclusive, other than pointing out the existence of a useful Polynesian male marker. The most interesting finding was the remarkable correlation between the maternal mtDNA data and the nuclear HLA data. The mtDNA results revealed that the mtDNA type ancestral to the Polynesian motif (with substitutions at 16217 and 16261) seemed to trace to Taiwan, consistent with linguistic evidence of the origin of the Austronesian language family in Taiwan (Fig. 1). The mtDNA ancestral to this type (with the substitution at 16217) was also observed in several of the Chinese in our study. There is a connection between mtDNA types from China, through Taiwan, to Polynesia. A similar pattern was observed in the distribution of a particular HLA marker (the DPB1 allele 0501), which is virtually absent in Europeans and Africans, but present at elevated frequencies in Chinese, Taiwanese, coastal and island Melanesians, and Samoans (Fig. 2). We concluded that these observations were consistent with the view that the Polynesians were the last offshoot of the expansion of Austronesian-language peoples, which probably traced its origin to the development of rice agriculture in southern China about 8000 years ago (Bellwood 1989). Although the Austronesian-language speakers spread into Indonesia, with a gradual transition from rice to a tuber-based agricultural system, we suggested that the strongest genetic connection of Polynesians was to Taiwan and China, rather than Indonesia.

A high proportion of the coastal and island Melanesians in our study (south coast of New Guinea and the Trobriands) had the full Polynesian mtDNA motif. We suggested that the sharing of identical sequences between Polynesians and present-day coastal New Guineans and Trobrianders was most likely due to a recent (last few hundred years) westward expansion of Polynesians. The presence

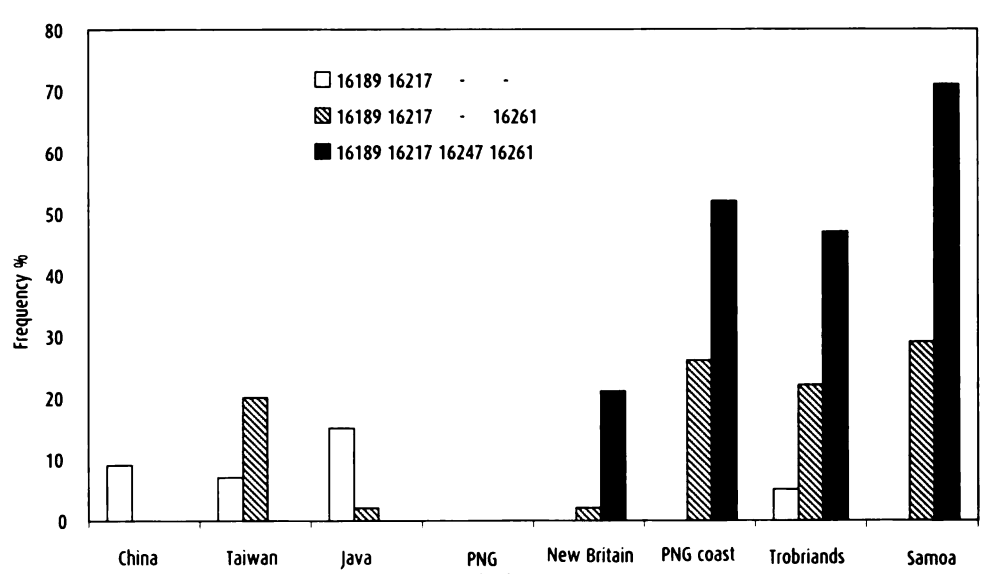

Fig. 1. Diagram showing the frequency of the Polynesian mitochondrial DNA motif (black columns) and ancestral types, in eight human population samples from Asia and the Pacific. The Polynesian motif occurs at high frequencies in parts of island and coastal Melanesia. An ancestral type closely related to the full Polynesian motif (striped columns) is also abundant in Polynesia, as well as in Taiwan (adapted from Hagelberg et al. 1999a).

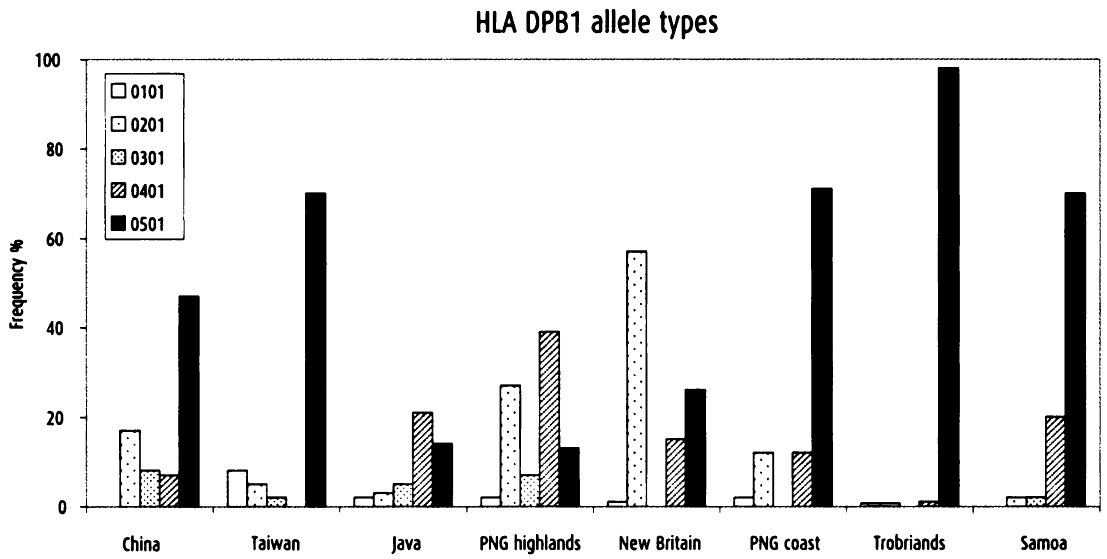

Fig. 2. Diagram showing the frequency of HLA-DPB1 types in eight human population samples from Asia and the Pacific. The so-called Asian allele 0501 is found at elevated frequencies in Polynesia and island and coastal Melanesia, as well as in China and Taiwan, but is less abundant in Indonesia and the New Guinea highlands (adapted from Hagelberg et al. 1999a).

of a small number of people in east Indonesia with the Polynesian motif was probably the result of recent incursions of Polynesians, and not proof that the Polynesians had originated in east Indonesia, as suggested by Redd et al. (1995) and Richards et al. (1998). The Polynesians were remarkably mobile, as witnessed by the occurrence of the Polynesian motif as far west as Malagasy (Soodyall et al. 1995). However, the answer to the question of the place of origin of the Polynesians will not be answered by genetic data alone, but will require direct evidence from archaeology.

Mitochondrial DNA types in Island Melanesia

Although most mtDNA surveys focused initially on the distribution of the Polynesian motif and related mtDNA variants in Polynesia and Southeast Asia, attention has been shifting to the human lineages which do not bear the 9-bp deletion, that is, those thought to be characteristic of the Austro-Melanesian peoples of the western Pacific. As mentioned earlier, Lum et al. (1994) and Sykes et al. (1995) described two other mtDNA lineages among the Pacific peoples included in their respective genetic surveys. Both these studies concluded that the two minor lineages which they observed on Polynesia were brought into the eastern Pacific with the principal mtDNA lineage (characterised by the 9-bp deletion and associated mtDNA substitutions). These authors found only very few examples of the presumptive second and third lineages among Polynesians.

In an extensive survey of mtDNA variation in the western Pacific, principally Vanuatu, but including the Trobriand Islands and the highlands of New Guinea, we also concluded that the vast majority (over 90%) of the mtDNA sequences that we detected fell into one of three lineages (Fig. 3). Our lineages I and II corresponded to the first two lineages described by Lum et al. (1994) and Sykes et al. (1995), but our third lineage was different to that observed previously by these authors in a small number of Polynesians (Hagelberg et al. 1999b). Our first lineage encompassed the Polynesian motif and related sequences with the 9-bp deletion. There was little sequence variation among people of this lineage, suggesting that they expanded recently from a small number of founders. This lineage accounted for approximately 90–100% of the mtDNA sequences observed within the Polynesian triangle (bounded by Hawaii, Easter Island and New Zealand). Moreover, Polynesian mtDNA types were also found

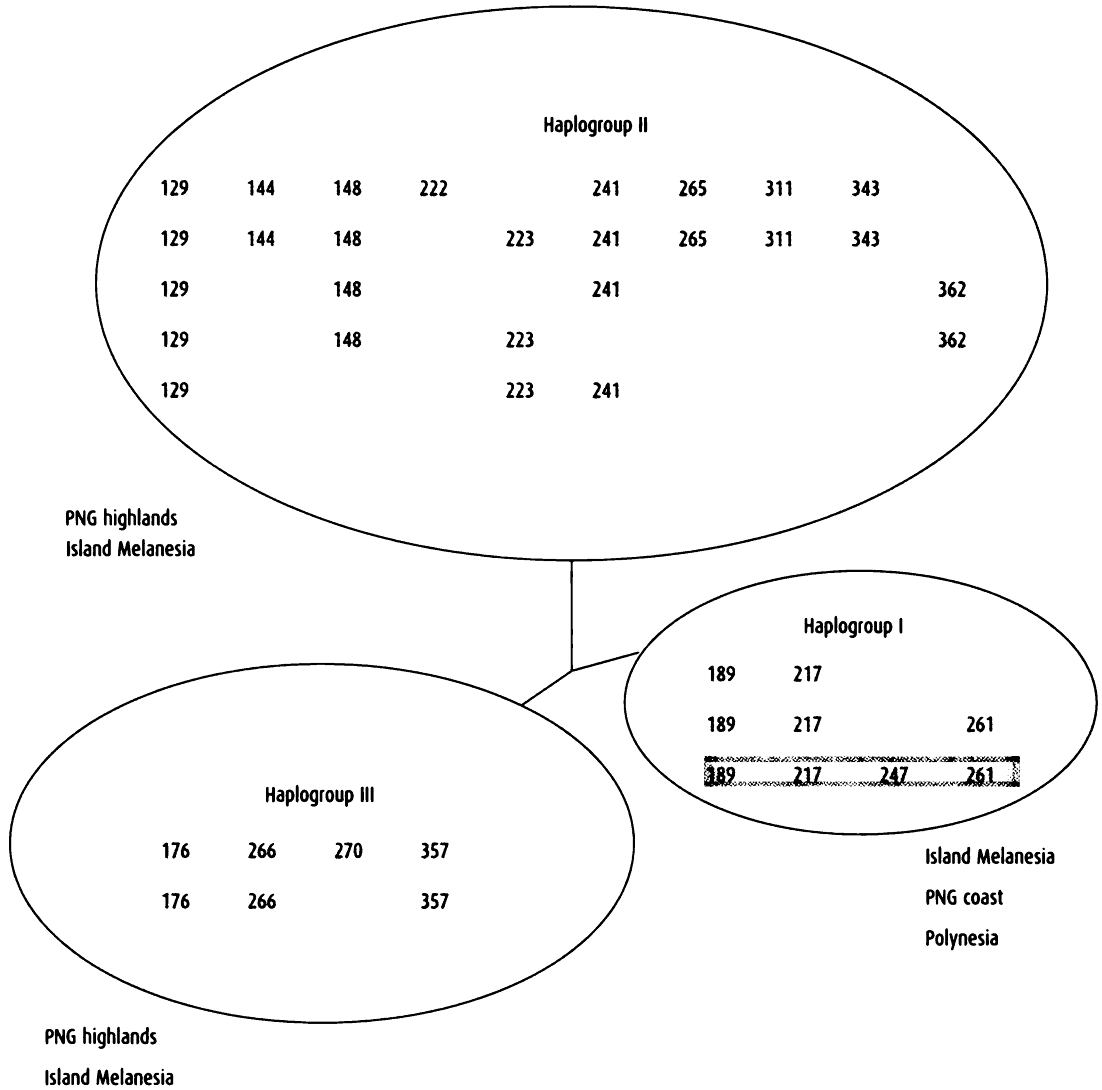

Fig. 3. Simplified illustration of a phylogenetic tree showing the three major mitochondrial DNA lineages found in the Pacific. The numbers refer to the position of the substitutions in the mitochondrial DNA hypervariable region, which characterise individuals who belong to each of the major groups, compared to the mitochondrial DNA reference sequence. The positions are in the sixteen thousands, but the 16 has been omitted from each figure for the sake of simplicity. Lineage I is characterised by the 9-base pair deletion. The Polynesian motif is shown in the dark grey box.

throughout Vanuatu, at particularly high frequencies in so-called Polynesian outliers such as Futuna, and also in the Trobriand Islands and the southeast coast of New Guinea. The wide geographical distribution of virtually identical mtDNA types argues for a recent, and possibly aggressive, expansion of peoples from Polynesia. The homogeneity of this mtDNA lineage, and its widespread distribution, are remarkable, and can be explained only by a stringent bottleneck in the settlement of Polynesia, followed by a rapid population increase and high mobility. The Polynesian mtDNA motif is absent in the highlands of New Guinea, although it is present in many coastal and island regions of Melanesia (Hagelberg et al. 1999a, 1999b; Merriwether et al. 1999) and, as pointed out earlier, is also found in east Indonesia and Malagasy (Redd et al. 1995; Soodyall et al. 1995). There is little doubt that this lineage is comparatively young in the Pacific, and traces back to a recent expansion of peoples which began in Asia. One might even be justified in calling this lineage an Austronesian lineage.

Pleistocene mtDNA lineages in the Pacific

The second mtDNA lineage we observed in our survey of mtDNA variation seemed to correlate to the second lineage described by Lum et al. (1994) and Sykes et al. (1995). We detected this lineage in many people from different islands in Vanuatu, and it was the principal type found in the highlands of New Guinea. The DNA sequences were very variable, but generally characterised by mtDNA substitutions at positions 16129, 16144, 16148, 16223, 16241, 16265 (a relatively rare change, called a transversion), 16311, 16343 and 16362, among others. Similar sequences were also observed in Indonesia and Taiwan, and we proposed that people of this lineage descended from the earliest Pleistocene settlers of Island Southeast Asia and New Guinea. We refrained from giving an age to this lineage (the errors associated with the calculation of divergence times for mtDNA lineages are so large as to make them virtually meaningless), but suggested that the high levels of variation were consistent with great antiquity. Interestingly, this mtDNA lineage bears a resemblance to some human mtDNA lineages observed in sub-Saharan Africa. We have shown that this Oceanic mtDNA lineage belongs to a large human mtDNA haplogroup (called by geneticists haplogroup M), which is widespread in Africa. It has been suggested that haplogroup M might be a genetic indicator of an early exit of modern humans out of Africa through eastern Africa and India (Quintana-Murci et al. 1999).

The third lineage we found in the western Pacific also appeared to be ancient, and widely distributed in New Guinea and Island Melanesia. This lineage was characterised by mtDNA substitutions at positions 16176, 16266 and 16357. We suggested, tentatively, that lineage III might have an ancient origin in Asia. The presence of a substitution at position 16357, an Asian-specific substitution, is suggestive. This substitution seems to be rare worldwide and is absent in Africa, but was observed in about 25% of our sample of New Guinea highlanders, and in about 50% of Andaman Islanders (Hagelberg unpublished observation). The presence of this substitution at high frequency in Oceanic peoples and Andamanese suggests that these two peoples shared an ancient common ancestor in Asia. It is tantalising to speculate that the 16357 substitution might be an archaic human signature in Asia, which survived to the present in humans living in isolated areas, but elsewhere in Asia was diluted by the gene pool of numerically superior Neolithic peoples.

The ages of these two Papuan lineages have been postulated to be approximately 122,000 years and 80,000 years respectively (Stoneking et al. 1990; Redd and Stoneking 1999). However, as with other age estimates, I have doubts about these validity of these figures. Molecular clock analyses are virtually useless for inferring human expansions as they are associated with very large errors. However, phylogenetic analysis of sequences belonging to the two ancient Papuan lineages indicated that, although both lineages seem to have very deep roots in the phylogenetic trees, the individuals belonging to each of the lineages form tight clusters (Hagelberg et al. 1999a; 1999b). The patterns of variation in lineages II and III might be explained by an ancient settlement of Sahul by a comparatively low number of people, followed by a demographic expansion in the past few thousand years, possibly due to the intensification of horticulture in the New Guinea highlands (Bayliss-Smith 1996).

Who were the Lapita people?

The results of our analysis of mtDNA variation in present-day people of Vanuatu indicated that the majority of the inhabitants in this archipelago fall in the three major lineages that we described previously (Hagelberg et al. 1999b). Our survey included Futuna, Tanna, Aniwa, Maskelyne, Lamen, Maewo, Nguna, Malekula, Paama, and Banks and Torres. Certain islands, most notably Futuna, but to a lesser extent Aniwa, Lamen and Malekula, had a high frequency of the Polynesian motif (Lineage I). Lineages II and III (Papuan lineages?) were most abundant in islands other than Futuna.

Although the first archaeological evidence of the human settlement of Vanuatu is associated with the Lapita complex, and goes back only 3000 years before present (see, for example, the paper by Anderson et al. this volume), the extent of genetic variation in Vanuatu is difficult to reconcile with this recent settlement. Traditionally, high diversity has been explained by antiquity. It is extraordinary that an island such as Malekula, which has one of the highest levels of linguistic diversity in the world, and also the highest mtDNA diversity of all the islands we surveyed, has a prehistory spanning just 3000 years. How can one explain the high levels of diversity in Vanuatu? Linguistic and genetic evidence would suggest that islands like Malekula might have been settled by humans before the development of the Lapita culture. This question needs to be answered by further archaeological work, although recent research on Malekula has not yet revealed any evidence of pre-Lapita occupation (Bedford 2000).

It might be argued that the linguistic and genetic diversity in islands like Malekula might be the result of recent migrations of 'non-Austronesian' peoples from their homelands in PNG and the Solomon Islands. This explanation might or might not work, and we need more detailed surveys of genetic variation (and much more archaeological information) to be able to answer this question with any degree of certainty. However, genetic surveys to date suggest to me that Polynesians were the most recent people to expand into parts of the Pacific. If this was the case, we would need to account for three major movements of peoples in Holocene Pacific prehistory: the Lapita people, followed by 'non-Austronesian' peoples bearing non-Polynesian genetic markers, and the Polynesians. The picture is far from clear, and this still does not answer the question, 'who were the Lapita people'. Our meagre evidence based on bone DNA typing indicated that Lapita and post-Lapita peoples were biologically 'Melanesian', rather than proto-Polynesian, whereas the bulk of the evidence based on the present-day distribution of mtDNA markers would indicate that the Polynesian expansion was very recent, and most likely post-Lapita.

To conclude, the patterns of variation in the apparently 'Austronesian' mtDNA lineage, characterised by the 9-bp deletion, would suggest that people of this lineage spread into Polynesia very recently, probably too recently to be associated with the Lapita culture. Thus, although there is little doubt that the Polynesians arrived recently from Southeast Asia, they were probably not responsible for bringing the Lapita culture, with its pottery, and chickens, pigs and dogs, into the central Pacific. Unfortunately, genetics provides no clear-cut answers, only more questions, to these fascinating issues (Hagelberg 2001).

Acknowledgements

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Textile technology and Austronesian dispersals

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Introduction

The linguist Robert Blust (1979, 1995, n.d.) has long held that weaving (like bark-cloth production) can be traced back to the proto-Austronesian period of Southeast Asian linguistic history. Blust has identified reflexes of *tenun* (weave cloth) in Austronesian languages spoken in Taiwan and Island Southeast Asia (Bali, Borneo, Java, Flores, the Moluccas, Roti, Sumba, Sulawesi and Timor), as well as in Madagascar. Blust's reconstruction is also based on ethnographic evidence for the backstrap loom on these islands, and its occurrence in several isolated locations in the Pacific (Banks Islands, Ontong Java, Santa Cruz Islands and the Carolines). Yet, reflexes of *tenun* are absent on those Pacific islands where the backstrap loom has been reported. Blust considers that the lack of cognate terminology in the Pacific leaves open the possibility of independent invention for the backstrap loom in Oceania. He says: "Whether the horizontal back loom is a sporadic retention or an independent invention in the Pacific, the sparseness of its distribution in comparison with insular Southeast Asia is a striking fact that is in need of explanation" (n.d.:33). This paper discusses the archaeological evidence for spinning and weaving in Island Southeast Asia and the Pacific and attempts to explain this problematic trait distribution.

Distribution of whorls

In Southeast Asia and the Pacific, climatic conditions are not conducive to the preservation of organic materials such as loom parts or prehistoric textiles. In these regions, spindle whorls are frequently the earliest extant remains of prehistoric cloth production. Spindle whorls are components of the hand spindle. They are the weights attached to wooden spindles through their central perforations. The wooden spindle aids in twisting and drawing out fibres and provides tension to hold spun thread in place by acting as a conventional bobbin (Barber 1991:42). The weight acts as a flywheel prolonging rotation. While it is possible to twist fibres without a whorl, spinning with the hand spindle extends the length and tensile strength of fibres and makes them well suited to loom weaving. For this reason, whorls provide indirect evidence for loom weaving.

Research shows that the earliest loom parts found thus far in China or Southeast Asia come from Hemudu, a site on the Ningbo Plains south of Hangzhou Bay in Zhejiang Province. The site (Fig. 1), located south of the Yangzi delta, has a basal Layer 4 dated to about 7000 BP. The anaerobic, waterlogged conditions at Hemudu have preserved wooden parts of backstrap looms along with remains of wooden-pile dwellings and boat oars. In one of the lower layers (Layer 3), 22.4% of the wooden tools were textile tools. This led Chinese archaeologists to conclude that: "Hemudu was a flourishing place for centuries as far as textile crafts were concerned" (Liu Jun and Yao Zhong Yuan 1992:96). Hemudu is also important for its possible ancestry in the sequence of cultures that later gave rise to proto-Austronesian society in Island Southeast Asia. Chang (1989:91) has observed that the material remains at Hemudu are literal transcriptions of the material culture reconstructed by Blust (1976) and Pawley and Green (1984) for the proto-Austronesians.

Hemudu produced large numbers (n=206) of spindle whorls made from wood, stone and pottery. Whorls were found in all four layers with wooden forms in the earliest layer. Several different types are represented. Some of the pottery whorls from the site are incised and a few have small concentric circles incised on their surfaces. Some of the design elements recorded on the spindle whorls from Hemudu are also featured in Kooijman's (1972) work on Polynesian *tapa* (see Cameron n.d.).

Regional differences in spindle whorls appear in the archaeological record of South China at sites belonging to the Tanshishan culture of Fujian Province. Except for the site of Fugoudun on Jinmen Island, the Tanshishan Culture is the earliest prehistoric culture identified in Fujian Province. According to Chang (1986:106–107), the Tanshishan Culture is one of the well-defined regional cultures of South China that sprang up around 5000 BP. Tanshishan sites are characterised by pottery, rice and large numbers of spindle whorls. What is important in this context is that some Tanshishan whorls are diagnostic. Kuhn's (1988) research into Chinese spindle whorls shows that while some basic types are widely distributed at sites in China, one of Tanshishan's whorls is culturally distinctive. Kuhn's (1988:Fig. 97) typology of Chinese spindle whorls clearly shows that biconical spindle whorls are unique to Tanshishan sites. For this reason, biconical whorls can be interpreted as cultural markers.

This research shows that the pottery biconical whorls from Tanshishan sites are paralleled at late-Neolithic sites on the island of Taiwan from about 4000 BP onwards. They have been found on all sides of the island (Tapenkeng, Oluanbi, Shanbi, Yinpu, Chishanyen and Peinan) (Fig. 1) and occur in the earliest layers at Tapenkeng (Chen Chung-Yu pers. comm.). Late-Neolithic pottery whorls from sites in Taiwan are also incised using the same design elements as their counterparts in Southeast China. Moreover, the Yami (an Austronesian-speaking group from the island of Botel Tobago) still spin with whorls that have the same morphology and decoration as whorls from Hemudu. In the Philippines (Fig. 1), prehistoric spinners with biconical whorls first appear around 3400 BP with rice. Biconical types have been found at Andarayan (Shutler pers. comm.), Arku Cave (Thiel 1986–1987) and Lal-lo (Aoyagi et al. 1993) (Fig. 1). Elsewhere, I have traced the movement of spinners with the same biconical whorls from Fujian Province into Hong Kong, Vietnam, Laos and Thailand (Cameron 2000). Like whorls from Hemudu those from the mainland are also decorated with concentric circles. While the meaning of the concentric circles is clearly conjectural, they could represent eggs or rice. Few spindle whorls have been found south of Luzon. A single pottery whorl was found in the Calamianes (Solheim 1964) and several on the island of Sumba (van Heekeren 1958). The whorl from the Calamianes is decorated with three rows of parallel lines. There are, however, unidentified pottery discs from sites in the western Pacific, which may have functioned as whorls. Spoehr's (1957) excavations at Objan on Saipan in the Marianas produced a reworked sherd worthy of closer examination. While this basic flat disc is not culturally distinctive, a similar whorl was found in association with biconical types at Andarayan. Reinman (1977) also excavated a pottery disc from a test pit on the Nomna Bay site on the island of Guam that compares favourably with the disc from Saipan.

Mainly to explain why spindle whorls do not appear south of the Luzon, Bellwood (1985:226) suggested that weaving might have been replaced by bark-cloth production. That is, spinning (like rice) was lost. While my research into prehistoric bark-cloth production clearly shows that prehistoric groups

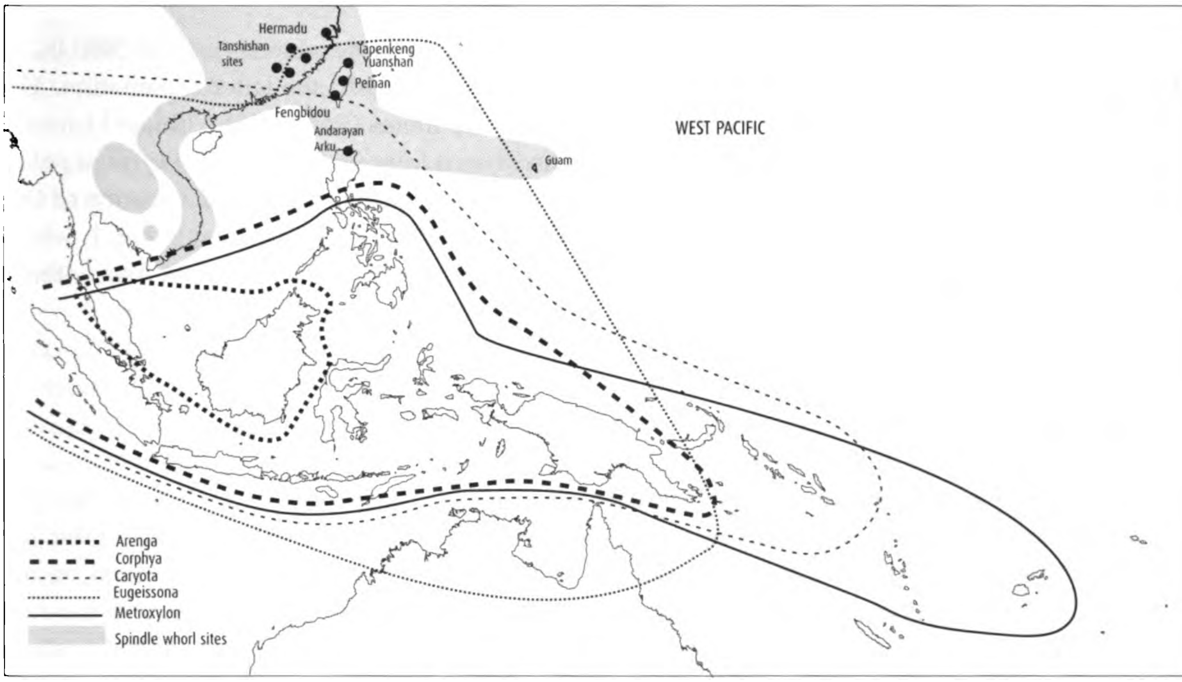

Fig. 1. Map showing distribution of spindle whorls and Old World Palm genera in Island Southeast Asia (after Ruddle 1978).

in Guangdong Province had bark-cloth technology 6000 years ago and that the technology dispersed into other parts of Southeast Asia during the Neolithic (Cameron 2000), there are several factors which suggest that the two technologies were not interchangeable and that loom weaving might not have been replaced by bark-cloth production in Island Southeast Asia.

Firstly, the cultural significance of textile production in Southeast Asia militates against lost technology. We know that textiles play a defining role in Austronesian societies where they are important social and ethnic symbols. On Roti, Ndao and Savu, for example, cloth has a central role in all life-cycle ceremonies including swaddling the newborn, wrapping and healing the sick, uniting the bride and groom, enclosing the wedding bead and shrouding the dead (Fox 1977).

Secondly, the spindle whorl evidence provides an incomplete picture of prehistoric cloth production. While pottery whorls no longer occur in the archaeological record of Southeast Asia (superseded by spinning wheels), whorls can be made from materials other than pottery that are not easily identifiable in the archaeological record. For example, spinners use shark vertebrae as whorls on the island of Lamalera in Eastern Indonesia (Barnes 1989), and on Timor perforated *Strombus* shells are used for spinning (O'Connor pers. comm.). Spindle whorls can also be made from stone, shell and bone and perforated discs of these materials have been found at archaeological sites in the Pacific where they have not been identified as whorls. Spinners from east Nusa Tenggara use wooden whorls (Hitchcock 1985) as do the Kenyah from Borneo (Tillema 1938). The presence of wooden spindle whorls in the earliest layers at Hemudu also suggests that the earliest Austronesian groups into Island Southeast Asia may have used wooden whorls, which have not survived. The main point is that spinning and weaving could have continued without being visible in the archaeological record.

Thirdly, the question is compounded by the fact that not all weaving is done with spun fibres. Some Austronesian-speaking groups in Island Southeast Asia and Melanesia weave unspun bast fibres on backstrap looms. The Igorot weavers from Sangir Island in the Philippines use unspun bast fibres on backstrap looms (Roth 1918). Weavers near Lake Jempang in east Kalimantan weave unspun basts that have been dyed using the *ikat* technique. Sobei weavers (Austronesian speakers) from Irian Jaya also use this technology (Howard and Sanggenafa 1999), as do weavers from Santa Cruz, Sikaiana, Rotuma and New Britain. Certainly, the usage of unspun fibres with simple backstrap looms by some groups complicates the origin question and raises the possibility of independent invention. It is also possible that the simpler technology diffused to the regions before spinning was developed (prior to 5000 BC in Southeast China) or from somewhere else in Asia. Three factors support the latter explanation. The Ainu from Japan weave unspun fibres on very simple backstrap looms (Roth 1918). Chinese historical sources (Pelliot in Eberhard 1968) indicate that cloths were woven from unspun *kuang-lang* (sago palm) fibres in South China more than 2000 years ago. Finally, and most significantly, the distribution of Old World palm genera (*Metroxylon, Arenga, Corypha, Eugeissona,* see Ruddle 1978) shown in Fig. 1, which are woven by many Southeast Asian groups coincides with the areas in Island Southeast Asia without archaeological spindle whorls.

Conclusion

In summary, this paper has demonstrated the movement of prehistoric spinners from sites belonging to the Tanshishan culture in Fujian Province into Taiwan, Luzon and possibly the Marianas in the late Neolithic (ca. 4000–3000 BP). It has also suggested that prehistoric spinners are represented on the island of Sumba. The presence of pottery whorls in the Marianas militates against independent invention of loom weaving in the western Pacific. The backstrap loom used by women in the Carolines today appears more likely to have been introduced during the late-Neolithic period by spinners who first moved across the Taiwan Straits to the islands of Taiwan and the Philippines before moving onto the Marianas. This paper has shown that while the presence of spindle whorls provides indisputable evidence for spinning, the absence of whorls does not necessarily preclude loom weaving. My reading of the evidence is that the spindle whorls discussed in this paper represent only one movement into the Indo-Malaysian Archipelago. Proto-Austronesians with bark-cloth technology, looms and sago palm weaving could have moved out of South China (Guangdong Province) into Island Southeast Asia considerably earlier than the spinners from Fujian Province discussed in this paper. This remains to be established archaeologically at sites where loom parts are recovered from excavations but not spindle whorls. Closer examination of stone and shell perforated discs from archaeological sites in Oceania could also reveal unidentified whorls. It is also possible that the prehistoric spinners discussed in this paper were Austro-Asiatic speakers and not Austronesians.

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Lapita dogs and singing dogs and the history of the dog in New Guinea

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Introduction

The history of the dog, *Canis familiaris,* in New Guinea is a topic that has been largely neglected by archaeologists, although the literature of culture contact with the people of New Guinea makes it clear that the dog is important to most people in New Guinea and the Pacific Islands (Baldwin 1990; Titcomb 1969). There is considerable variety in the kinds of dog present and the nature of their relationship with people. These variations are both economic and social. There is a widespread belief that most Pacific people traditionally ate dogs and that this was the dog's primary use, but in fact it appears that the eating of dogs was rare (Baldwin 1990:239). In many New Guinea societies dogs were not eaten at all, and people found the idea repugnant. Even where dog flesh was acceptable, people varied in their appreciation of it (e.g. Chowning 1991:184). On the other hand, in some New Guinea societies dogs were the primary source of meat. Dogs are classic "walking larders" (Clutton-Brock 1989); they are omnivores and adaptable, enthusiastically eating any surplus plant and animal food, storing it 'on the paw' until their flesh is needed at a later time. Dogs can actually look after themselves too; they fish and hunt and eat wild fruits and nuts and carrion. Dogs were also economically important as hunting assistants, but were to some extent competitors with humans for available food, whether given to them or hunted or stolen for themselves. Dogs are a tradable commodity as well, particularly pups. And most dogs survive and thrive in any circumstances that human choose to live in, and far beyond.

Dogs have other important social functions in New Guinea communities, as they do in human society generally (Groves 1999), which tend to be ignored by archaeologists focused on 'subsistence'. Dogs are valued as companions, pets, surrogate children, blankets and guard dogs. They also contribute to the health of the community by cleaning up garbage and other refuse. On the other hand, dogs can be terrible pests, eating chickens and piglets and harassing domestic pigs, although in at least one case dogs were trained to keep the pigs out of the garden. Some communities decide not to have dogs at all, but the resolve rarely lasts long. Virtually all New Guinea societies condone dogs as a part of the community and most welcome them.

This complex picture refers only to the recent past, mainly to the 19th and 20th centuries, and this paper begins the process of attempting to understand the earlier history of New Guinea dogs by looking in detail at the archaeological evidence of dogs in New Guinea sites. It will begin with the archaeological evidence in Lapita sites of the Bismarck Archipelago to the east of New Guinea, to search for support of the general hypothesis that the dog, along with the pig and chicken, were first brought to New Guinea and the west Pacific by Austronesian language-speaking immigrants who made Lapita pottery. Then the archaeological evidence for dog in the New Guinea Lowlands and Highlands will be reviewed. All of this evidence will be looked at critically, including its stratigraphic context, its dating, and the nature of the evidence itself, not only dog remains but other signs of the dogs' presence.

The archaeological evidence for dog will also be set in the wider context of the archaeological knowledge of New Guinea prehistory in general and of its fauna, including the discovery of the early transport of wild animals between islands. The question of the rarity of dog remains in New Guinea sites will be considered in light of ethnographic evidence of the relationship between humans and the New Guinea wild dog of the high mountains and its possible antiquity. Then the possible origins of the New Guinea dog will be briefly reviewed, including both wild and domesticated dogs in Southeast Asia, whence New Guinea dogs presumably came.

Archaeological evidence of dogs in the Bismarck Archipelago

The following discussion will begin with a review of evidence of dogs at Lapita sites, followed by a brief consideration of whether there may have been dogs in the Bismarcks in earlier times. Then a sample of more recent sites with evidence of dog is discussed.

Lapita dogs

Dogs were part of the 'Lapita Cultural Complex', the culture of the first Austronesian language speakers in the Bismarck Archipelago area. Archaeological evidence of this culture is found at a large number of sites in the Bismarcks and the islands to the east where the distinctive Lapita pottery occurs dating to the period 3500 to 2500 BP (Kirch 1996:60). "It [Lapita pottery] marks the first appearance of three Pacific domesticates, the pig, dog and chicken, and therefore the beginnings of Pacific animal husbandry" (Spriggs 1997:88). It is argued that the dog, pig and chicken were domesticated not only because they needed human assistance to arrive in the Bismarck Archipelago sites, but also because such animals would have needed to be fed by humans, given a presumed lack of natural resources to support them, implying the presence of agriculture. The dog is also argued to have had a particular importance in contributing to environmental change on newly settled islands by helping humans to hunt indigenous birds and animals to extinction. The extent to which this occurred is thought to have varied, as does its presence in the archaeological record (Flannery et al. 1988), although in Polynesia dog remains are relatively common (Steadman 1997:51, 65).

Evidence of dog at Lapita sites in the Bismarck Archipelago is at present very limited, but this may reflect more the scarcity of faunal material at the sites so far investigated than the dogs' actual rarity. Of 29 Lapita sites investigated during the Lapita Homeland Project, only five sites are presented as having evidence of fauna (Gosden et al. 1989:Table 4), as has a sixth site, Kamgot, more recently investigated in the Anir Islands (Summerhayes pers. comm.). All six of these Lapita sites contain pig bone, but only three, Talepakemalai, Apalo and Kamgot, also contain evidence of dog. Thus the presence of dog is not uncommon (50% of sites with faunal midden) and it is also widespread, i.e. it is found in three separate Lapita sites in Mussau, Arawe and Anir Islands. On this evidence it can be expected that further evidence of dog is likely to be found in Lapita sites at Talasea, Kandrian and Watom on New Britain, and on New Ireland, Nissan and Buka.

The three Lapita sites with evidence of dog (Table 1) are different kinds of sites, although no detailed evidence is yet available.

Table 1. Archaeological evidence of dog in New Guinea.

SITE	EVIDENCE	AGE (YEARS BP)	REFERENCE
BISMARCKS			
Talepakemalai (ECA)	3 unidentified	3500–2500	Kirch 1988:Table 3
Apalo (FOJ)	no details	3500–2500	Gosden et al. 1989:Table 4, 573
Kamgot (ERA)	no details	3500–2500	G. Summerhayes pers. comm.
POST-LAPITA			
Lesu (EAA)	12 teeth, 2 bones	2000–1500	White and Downie 1983:198, Fig. 2
Hangan (DAI)	no details	1860	Flannery et al. 1988:89
LOWLANDS			
Ramu			
Akari (JMF)	2 canine teeth	5500	Swadling et al. 1991:106–107
Beri	1 canine tooth	5500	Swadling 1997:Fig. 4, pers. comm.
PAPUAN COAST			
Oposisi (ADI)	4 canine teeth	2000–700	Vanderwal 1973:155
Urourina (ADG)	charred dog bone	720	Vanderwal 1973:155
Nebira 2 (ACJ)	50 canine teeth	ca. 750	Bulmer 1978:169–172
Nebira 4 (ACL)	canine teeth	1760–880	Alllen 1972:97–99, Table 9
Eriama (ACV)	20 canine teeth	<500	Bulmer 1978:228, 238–244
Taurama (AJA)	pup burial, fragmented bone	2500–2000	Bulmer 1978:297–299
Motupore (AAK)	bone, canine teeth	850–recent	Allen 1991
Mailu 01	mandible fragment	2000–recent	Irwin 1985:223, 237, Tables 65, 67
Mailu 03	2 canine teeth, animal bone fragments		Irwin 1985:223, 237, Tables 65, 67
Selai	2 canine teeth		Irwin 1985:223, 237, Tables 65, 67
Rainu (HAC)	5 canine teeth, 1 M1, fragmented dog bone, coprolites, fragmented animal bone	950–500	Egloff 1975:37, 91
HIGHLANDS			
Aibura (NAE)	1 PM3	<770	White 1972:57
Kiowa (NAW)	fragment of mandible, 2 ?cranial fragments	ca. 3000, 4820 and ca. 7000	Bulmer 1969, 1979
Nombe (NCA)	2 canine teeth	<5000	Mountain 1991:7.19, 8.5
Kanamapin (QBA)	1 tooth	recent	Gorecki 1989:153; Pernetta 1989:193–194
Kamapuk	1 item	<1200	Aplin 1981:56–57
Mapala	1 skull	<5440	J. Hope 1976

Talepakemalai (ECA) (Kirch 1988:Table 3). Dog is present at this site in the Mussau Islands, northwest of the northern end of New Ireland. This is an open settlement site of some 120,000 sq m and ca. 400 m inland from the beach. Different areas of the site contain material, including faunal remains, relating to different periods in the sequence of Lapita occupation, with a wealth of organic material preserved in wet condition beneath the present island aquifer.

Apalo (FOJ) (Gosden et al. 1989:Table 4). Dog bone and/or teeth have also been found at one of five sites excavated in the Arawe Islands, at the southwestern end of New Britain. Apalo, on Kumbun Island, has a thick layer of beach midden deposit.

Kamgot (ERA). Dog canine teeth have been found in recent investigations at extensive beach midden sites with Lapita pottery on Babase in the Anir Islands, southeast of New Ireland (Summerhayes pers. comm.).

No detailed analysis of the dog remains is yet available, such as their precise stratigraphic position and date of introduction. There is no analysis yet of the possible purpose of these dogs, and evidence of quantity is given for only one site so far, Talepakemalai, where three identified items of dog were among some 21,000 identified items of animal bone reported in a summary table (Kirch 1988: Table 3). Dog bone comprised only 0.2% of the 4929 pieces of identified vertebrate remains, the rest of the fauna comprised 75% fish and 20% marine turtle (Kirch 1987:Table 3). Although this evidence shows dog remains to be rare at this site, given the large size of the site this may not be significant, due to sampling error. Sampling error, taphonomic variations (e.g. Kent 1981; Spennemann 1990; Walters 1984), as well as selectivity in the disposal of animal bone (R. Bulmer 1976), could account for dog's absence or quantitative rarity. However, given the present state of evidence at Lapita sites, including the absence of other kinds of evidence of dog, such as has been found at sites in coastal New Guinea (see below), no significance can at present be given to the small amount of dog at the one site.

On the other hand, there seems to be sufficient evidence of dog in Lapita sites in the Bismarcks to dispose of an argument based on linguistic evidence that the early Lapita settlers had 'lost' their dogs prior to their arrival in New Guinea. This suggestion is based on the lack of a credible Proto-Oceanic term for dog among languages in the Bismarck Archipelago, the variation in names of dogs in New Guinea and Island Melanesia, and the distinctive name for dog in the central Pacific islands, where dog bone is present in Lapita sites (Blust 1996:32; Hudson 1989:283; Lynch 1991:421–422, 427; Nagaoka 1988, but see Chowning 1991:52). It has been suggested that the dog was 'lost' because the dog had no useful function in Oceanic islands, given a lack of terrestrial animals for it to hunt and because it was a competitor with humans in times of famine. This is a search for excuses where none are needed; the Lapita settlers did have dogs although we do not yet know much about them. Whether they were kept domestically, whether they were eaten, whether they were used as hunting assistants, or whether they were simply pets, remains to be discovered. The Lapita settlers in the Bismarcks might have obtained dogs and dog products (meat, ornaments, tools) from non-Lapita neighbours or from maritime traders, who had been in contact with the Bismarcks from 5500 BP or earlier (Swadling 1996:52ff).

It will be interesting for DNA testing to be carried out on Lapita dog bones and teeth from the Bismarcks, as it is likely that they will belong to an Oceanic lineage already defined (Matisoo-Smith et al. 1998). A sample from the puppy burial at the Taurama site, near Port Moresby (S. Bulmer 1978:297–299 and discussed below), shows it belongs to an Oceanic DNA lineage. This puppy was buried in a small oval pit, probably in the ground surface beneath or near a house on stilts on the beach. This occupation was associated with Lapita-like pottery that is estimated to date to ca. 2500–2000 BP and possibly reflects the settlement of people either from Lapita communities on New Britain or from similar settlements in eastern Island Southeast Asia (S. Bulmer 1999).

Pre-Lapita dogs?

Although there are detailed faunal sequences from a series of rock shelters and caves on New Ireland that together provide a faunal sequence for New Ireland from 33,000 BP to recent times, there is no sign of dog in these sites in pre-Lapita layers, layers contemporary with Lapita, or more recent layers (Allen 1996). However, given the kind of evidence so far available and the presence of earlier dog in the Ramu area, discussed below, this negative evidence of dog should not be taken to be proof of the absence of dog. One important factor is that the New Ireland faunal sites are camps of hunter-foragers and in comparable faunal deposits in the Highlands, dog is not present. In the Highlands, it was only in relatively recent times, when the rock shelters were used in the vicinity of gardens and settlements, that dogs were present. This does not mean that dogs were not present in earlier times and in association with hunters, but that they were not left at the hunting campsites. The dog is likely to have been brought to the Bismarcks in pre-Lapita times, in spite of the negative evidence so far, as the pig was transported by humans to New Ireland in the early Holocene, the total evidence for which is two teeth, one each in layers dated to 8000 BP and 6000 BP (Allen 1996:22). Given the very limited evidence so far available for dog in the Bismarcks, it is more prudent to keep the issue open for the present and to consider the possibility that dog was also brought to the Bismarcks in early times; a potentially likely scenario given the dog's unusual and generally important place in human society.

Post-Lapita dogs

The end of the Lapita occupation in the Bismarck Archipelago was in the period 2500–2000 BP, when some Lapita sites were abandoned, others reflect major cultural change, and still other sites were newly occupied. Evidence of dogs has been found at the newly occupied sites of this period, at beach and inland middens associated with non-Lapita pottery (Table 1). Two examples:

Lesu (EAA). On New Ireland, Lesu contained 10 items of dog (nine teeth and one bone) found in Mound V, and four items of dog (three teeth and one bone) found in Mound VI. These mounds were in a group of house mounds dated to <2500 BP (White and Downie 1983:198, Figure 2) but have a likely age of 2000–1500 BP (White pers. comm.). Most of the midden bone at the site was fish. This contrasts with the occupation layers of this period at the inland Balof Cave (EAE), which did not contain any dog bone, and had a mostly marsupial fauna (Downie and White 1978:769–776).

Hangan (DAI). A midden site on Buka Island (Wickler 1991:144) with dog bone in a layer dated to 1860 BP, but no further details have been published (Flannery et al. 1988:89). The latter paper speculated that dog may have been introduced earlier, on the basis of the extinction of two species of rat. Dog was previously reported at Buka sites associated with the post-Lapita Sohano-style pottery (Specht 1969:200).

Archaeological evidence of dogs in Lowlands New Guinea

Unlike New Ireland, where a series of detailed studies of fauna from early hunting sites is available, in Lowland New Guinea there is no such evidence of early fauna. However, there is potential in three lowland sites of Taora, Lachitu and Kowekau. Lachitu (RIQ) is a coastal rock shelter with midden deposit and an occupation that began ca. 35,000 BP and Taora (RIU) is another coastal rock-shelter midden occupied from the mid-Holocene (Gosden 1995:810; Gorecki pers. comm.). A list of the fauna from the early-Holocene layers at Lachitu has been published (Gorecki et al. 1991:121), but the late-Pleistocene material is not included. Kowekau (Swadling 1997:6), also referred to as Seraban (Swadling et al. 1988:40), is a rock shelter near Timbunke on the Middle Sepik River that contains occupation deposits dating from 14,500 BP to 6000 BP. This includes faunal material, but no description of it has been reported. Bobobongara, the earliest Lowland human settlement site in New Guinea, dated to between 60,000 and 40,000 BP (Groube et al. 1986; Spriggs 1997:39), is on a raised coral terrace on the Huon Peninsula and contains only stone artefacts. Thus the absence so far of any evidence of early dogs in the New Guinea Lowlands is not significant, and there may be good reasons, discussed below, to anticipate their eventual discovery.

Dogs in mid-Holocene sites in the Ramu Lowlands

Akari (JMF). The site is one in a series of midden sites on the shores of the mid-Holocene Sepik–Ramu inland sea, two of which contain evidence of dog (Swadling 1997) (Table 1). Akari has a 2 m deep deposit of stratified shell and bone midden. Two dog canine teeth were found, one in Spit 4 and another in Spit 6 (Swadling et al. 1991:106; Swadling pers. comm.). These deposits are dated to ca. 5500 BP and are thought to result from a short-term occupation of perhaps 100–200 years around the time of the high sea level on the Sepik–Ramu inland sea. Two series of dates, on shell and charcoal, have been run for these deposits, with the shell series agreeing with the geological age of the shoreline. The charcoal dates are more recent, but are thought to reflect the much more recent burning of trees on the site, the roots of which penetrate deeply into the stratified deposits.

Beri (Swadling 1997:Fig. 4, pers. comm.). Another site on the former high-water-level shore of the Sepik–Ramu inland sea, in a similar position to Akari. It has only been test-excavated, but this showed that deposits on the site's surface relate to its early occupation (Swadling pers. comm.), i.e. ca. 5500 BP, similar to the dating of Akari. A single dog canine tooth was found on the surface of the midden.

Dogs in late-Holocene sites on the Papuan coast

Sites in four areas of coastal Papua have been investigated and dog has been found in all four areas (Table 1). These include sites on the southern Papuan coast, at Yule Island (Oposisi and Urourina), Port Moresby (Nebira 2, Nebira 4, Eriama, Taurama and Motupore) and Mailu (Mailu Island 1 and 3 and Selai). These sites are thought to all relate to the arrival of Austronesian-speaking groups at ca. 2500–2000 BP and two millennia of subsequent occupation. Another area on the northern Papuan coast, Collingwood Bay, which shows more recent occupation from ca. 900 to 500 BP, also contains evidence of dog.

Five sites at Yule Island and on the nearby mainland were excavated (Vanderwal 1973), but evidence of dog was found at only two sites.

Oposisi (ADI): A hilltop midden on Yule Island, with a series of layers reflecting virtually the full sequence of occupation on the island, from ca. 2500 to recent times. Four perforated dog canines were found in Layers IA (the most recent), IIA and possibly IIC (the earliest) and one was unprovenanced. Perforated dog canine teeth are used widely in the area today in personal ornaments, and as there was no other sign of dog it was assumed that the ornaments were obtained from people on the mainland through trade (Vanderwal 1973:155).

Urourina (ADG): Also excavated by Vanderwal (1973:155), the site is an elongated mound on the beach on the mainland with 160 cm of midden deposit. This midden contained charred dog bone including the mandible, maxilla, radius, tibia and ulna. This suggests that dog had been cooked and eaten by the occupants and probably reflects the keeping of dogs locally. Urourina was occupied at about 720 BP.

The sites near Port Moresby at Nebira, Eriama, Taurama and Motupore represent large long-occupied settlements. Excavations at Nebira and Eriama, near the Laloki River, inland from Port Moresby, and at Taurama and Motupore on the coast provide evidence of dogs. A fourth group of sites nearby at Boera has also been investigated, but no faunal data has been reported.

Nebira 2 (ACJ) (S. Bulmer 1978:169–172): An inland hilltop site near the Laloki River where 50 perforated dog canines were excavated in association with a group of more than 40 human burials dating to about 750 BP. Some of the canines were in position around the neck or waist as ornaments on particular individual burials, while others were scattered nearby, probably belonging to earlier burials that had been disturbed by the reuse of the same burial pits. The 58 canines (NISP) reflect an MNI of 15 dogs, compared with a total of 119 other items of identified animal bone, and more than 1000 small animal-bone fragments from another 12 species. There were no dog bones, but from the fragmentation of other bones into tiny bits and their scattering over the site area, which contained post holes from a number of former houses, this is thought to indicate the presence of free-ranging dogs. It is not thought that free-range pigs were present as the ground surface had not been disturbed. The dog canines at Nebira 2 were made into several kinds of personal ornament, with not only necklaces, but also a hair top-knot ornament and part of a composite ear ornament identified.

Nebira 4 (ACL) (Allen 1972): The site is a 225 cm deep stratified shell-midden site at the foot of Nebira hill, representing occupation on the lower slopes of the hill facing the Laloki River. This appears to have been initially occupied at the same time as the hilltop nearby, although a buried soil at about 60 cm depth showed the most recent occupation was some time after 880 BP (Allen 1972:99). There was a necklace of perforated dog canine teeth and small shell beads around the neck of one of the two articulated burials found in Level 10 at ca. 120 cm depth (Allen 1972:97). There were also other perforated canines in Levels 13 and 16 (Allen 1972:Table 9), probably related to earlier burials. A date for Level 14 of

1760 BP is some 75 cm above the base of the midden (Allen 1972:99) where the pottery style suggests an age earlier than 2000 BP. The number of dog canines was not reported and there was no other evidence of dog. This is similar to Nebira 2 where dog tooth ornaments were also present, but where other evidence suggests that dogs were kept there. Like Oposisi, Nebira 4 had no other evidence of dog, but there is a high degree of fragmentation of other animal bone, particularly in Levels 1 to 8 (Allen 1972:116), which may be similar to the fragmentation attributed to dogs in the nearby Nebira 2 site.

Eriama (ACV) (S. Bulmer 1978:238–244): Another group of sites inland from Port Moresby, probably reflecting a large village, on a low ridge near the Laloki River, 5 km upriver from Nebira. This group of sites included a small rock shelter that contained 46 secondary burials, as well as occupation deposits probably from mourners staying at the shelter in connection with burial rites. The burials probably date to <500 BP (S. Bulmer 1978:213). A total of 20 dog canine teeth are present, 16 perforated and four fragmented (MNI=5). All are thought to have come from ornaments associated with the burials (S. Bulmer 1978:228). The dog canines were found in the upper layers where nearly all of the other animal bone occurred, but there was no other dog bone or other evidence of dog, such as gnawed and fragmented bone. The relatively good condition of the animal bone and the presence of a large amount of human bone on the surface indicate that pigs and dogs were not kept in the vicinity of the site or that it was fenced off from them.

Taurama (AJA): A coastal village site with evidence of occupation from ca. 2500–300 BP, containing two kinds of evidence for dog (S. Bulmer 1978:297–299). An articulated burial of a puppy was found in a small pit on the surface of the earliest occupation layer, IIB, which represented the ground surface under a former pole house. This layer is associated with red-slip dentate-stamped pottery of a style dated at other sites to ca. 2500–2000 BP (S. Bulmer 1999). The other animal bone at this site consisted of a scatter of tiny fragments on the ground surface. This probably resulted from the feeding of bone to free-ranging dogs; it is not likely to result from pigs, as the ground surface was not disturbed. The animal bone in a midden heap at one side of the village probably reflects the sweeping of fragmented material from the ground surface around the houses, as it was in a similar condition.

Motupore Island (AAK): This site was occupied from about 850 BP until recent times (Allen 1991), and contained both dog bone and perforated dog canines, but no details have yet been published.

Sites at Mailu to the east of Port Moresby (Irwin 1985:237, Table 67) contain evidence of dogs from the beginning of their occupation at ca. 2000 BP to recent times. The two Mailu island sites are middens in the area of the present village, and the Selai midden is a village site on the mainland coast.

Mailu 01: Three fragments of dog jaw were found in Layer G, the earliest layer, and a number of unperforated canine teeth were present in more recent layers.

Mailu 03: Two items of dog teeth or bone were recorded (Irwin 1985:Table 67).

Selai: Two perforated dog canine teeth were present (Irwin 1985:223, Table 65). Dogs as well as pigs were thought to have been responsible for the disturbance and redistribution of the village middens (Irwin 1985:224), but the presence of dog bone in the middens did not necessarily indicate the eating of dog (Irwin 1985:237).

At Collingwood Bay on the northern coast of Papua archaeological investigations produced extensive evidence of dog.

Rainu (HAC): House sites on midden mounds in swampy ground were occupied from ca. 950–500 BP (Egloff 1975). Excavation at two of the mounds revealed evidence of dog in nearly all layers, generally a few small fragments of bone, but one layer had 13 fragments of dog bone. Other signs indicating the presence of dog included the fragmented condition of large bones and an absence of small animal bones, which were presumably consumed by dogs (Egloff 1975:37). There were also a few dog coprolites containing many small fish bones, and five perforated canine teeth and one first molar, similar to those used locally as ornaments (necklaces, ear ornaments and head bands) in recent times. Dogs are still kept in the vicinity of the sites as hunters and guard dogs (Egloff 1975:91), but dogs are not eaten, nor does the archaeological evidence support this.

Archaeological evidence of dogs in the Highlands

Dog has not featured strongly in discussions of the prehistory of the Highlands, as it is assumed that it arrived only in relatively recent times (Golson and Hughes 1980:300). Dog has been found at six sites (Table 1), or 46%, of the 13 rock shelters and caves that have been excavated in the Highlands, but was not present at any of the four open settlement sites where faunal material has been recovered. The rock shelter and cave sites collectively provide faunal sequences from ca 33,000 BP to recent times.

The sites with evidence of dog are widely distributed around the Highlands (Table 1). They will be discussed from east to west.

Aibura (NAE) (White 1972:51–82): This cave site at 1640 m asl near Kainantu contains 160 cm of fine dark silt deposit from more than 3800 years of occupation (White 1972:57). Dog was found in Horizon I where there was a large number of white ash lenses from fires in the upper 50 cm of deposits. A third premolar dog tooth was found in Level 1 in an assemblage containing 23 animal bones. The base of Horizon I (Level 4) dates to less than 770 BP (White 1972:57). Horizon I also contained post holes and may reflect the use of the cave as a refuge or by visiting hunters.

Kiowa (NAW) (S. Bulmer 1969, 1975:35–36, 1979): This is a rock shelter at 1530 m asl near Churave in the Simbu Province, with ca. 400 cm of human occupation deposit, occupied from about 10,350 to 3000 BP. A fragment of a dog mandible was found on the surface of Layer 2 next to the cliff face, and is possibly a trophy item associated with nearby human pit burials in the top of Layer 2 and in crevices in the cliff above the site. Two cranial fragments, possibly of dog, were found in Layers 3 and 7, also next to the rock face, but have unfortunately disappeared from the faunal collections since their recording in the catalogue. Layers 1 and 2 are undated, but the top of Layer 3 is dated to 4820 BP, and Layer 7 is >6100 BP.

Nombe (NCA) (Mountain 1991:7.19, 8.5): Dog was found at Nombe, a rock-shelter site at 1660 m asl 4 km to the southwest of Kiowa. Nombe was occupied by humans from at least as early as 33,000 BP, but it is not clear whether some of the earlier deposits were left by the marsupial wolf, *Thylacinus cynocephalus*, rather than humans. Two dog teeth (MNI=1) were found in Layer A, a complex and disturbed layer, the base of which is dated to ca. 5000 BP.

Kanamapin (QBA) (Gorecki 1989:150–153): This rock shelter at 280 m asl is in the lower Jimi Valley–Yuat Gorge area, between the Jimi, an intermontane valley that is in many respects part of both the Highlands and the Lowlands. It contained a single dog tooth found on the basal rock below 100 cm of partly disturbed deposit. The deposit returned modern dates (Gorecki 1989:153). Both charred and uncharred fragments of animal bone were present, totalling 926 NISP (Pernetta 1989:193–194), and patches of burning were considered to be evidence of cooking fires. A human skull was found in a niche of the shelter and local information indicates that the shelter formerly contained other human bones, and thus it is possible that the dog tooth was present in the site as part of a burial ornament.

Kamapuk (MKK) (Aplin 1981; Christensen 1975): A rock shelter at 2050 m asl, one of a series of four shelters excavated at different altitudes in the Manim Valley, a southern tributary of the Wahgi Valley. This is the only site of the series that so far has had faunal collections reported, but the analysis of the others is in progress (Aplin pers. comm.). A single item of dog bone was found in Unit I, Zone K4, dated to less than 1200 BP (Aplin 1981:56, 67), out of a total of 4692 items of identified bone in this site.

Mapala (J. Hope 1976; G. Hope pers. comm.): A rock shelter at 3996 m asl that was excavated during the Carstenz Glaciers Expedition. In the area Singing Dogs were frequently observed, and dog faeces were widespread up to 4700 m. The Mapala shelter had three layers, the deepest of which contained little bone and was dated to 5440 BP. Two other dates have also been run (G. Hope pers. comm.), indicating the upper layers are more recent. The middle layer contained dense bone, a sample of which produced an MNI of 73 animals, comprising 20 species. The skull of a juvenile dog was found in the shelter. The upper layer was fire ash, the result of local hunters burning the bones of their kills to improve the fertility of the remaining animals (G. Hope pers. comm.).

Summary of Archaeological Evidence of New Guinea Dog

The available archaeological evidence suggests that there were dogs in widespread localities in the Bismarck Archipelago in the period 3500–2500 BP when Lapita pottery-making communities were present. Dog has been found at three of the six sites that contain both Lapita pottery and faunal deposits. The significance of these finds is as yet uncertain, as few details have been published. Information about quantities is lacking for all but one site, Talepakemalai, where only three items of dog are listed in a summary table of fauna. Thus the theory that Lapita immigrants from Southeast Asia introduced the domestic dog to the Pacific Islands remains theory for the present, as does the suggestion that the Lapita settlers of the Bismarck Archipelago area 'lost' the dog. DNA testing may assist in learning about the origins of these dogs in the Bismarcks, but no samples have yet been studied. They could be related to one or other of the two DNA lineages of New Guinea dogs established so far, the Pacific dogs and the Singing Dogs, and it can be anticipated that Lapita dogs belong to the former, as did the puppy buried at Taurama in southern Papua. In the meantime it is possible to say only that the people who lived at the sites with Lapita pottery in the Bismarcks either kept dogs themselves, or obtained dogs or dog products from their neighbours or visitors.

It is notable, however, that there are no signs of dog in the cave and rock-shelter sites on New Ireland, before, during or after the Lapita settlements, but it seems unlikely that dogs were not present in the Bismarcks at least as early as they were on the mainland of New Guinea, or that dog was not brought to the Bismarcks as early as pig, i.e. by ca. 8000 BP. Even if people did not hunt dogs or eat them, at least they are likely to have kept them as pets. The lack of evidence for Pleistocene or early-Holocene dog in the New Guinea Lowlands has to be considered not significant, as there are as yet insufficient details available for the only three early faunal sites excavated in the Lowlands. The earliest evidence of lowlands dogs is in the mid-Holocene, at two sites associated with Sepik–Ramu inland sea. These sites are near the shoreline of the high sea level of the inland sea which is dated to ca. 5500 BP, on the basis of both geological and archaeological dating. Two midden sites on this shoreline, Akari and Beri, contain dog canine teeth, and the other evidence from these sites and another of the same period, Dongan, is that they were associated with a group of communities that had pottery, pigs, arboriculture and long-distance obsidian trade with New Britain (Swadling 1997). Because of the firm dating of the geological events associated with the human occupation, these findings challenge the theory that the Lapita pottery makers were responsible for the first introduction of domestic animals and pottery to the New Guinea area, although the jury must remain out until Lapita-site evidence from the Bismarcks is available.

Evidence of dog is widespread in New Guinea Lowlands and Highlands in late-Holocene sites, but nearly everywhere it consists of only one or a few items of bone or teeth. The commonest evidence in a series of sites along the coast of the Papuan peninsula are perforated dog canines, used in hair and ear ornaments and in necklaces. Some of the ornaments were found in direct association with burials, but most are stray items that have apparently been dropped accidentally or discarded broken. Another site has a perforated dog molar, suggesting a more general use of dog teeth as ornaments. Only two sites have substantial quantities of dog bone (more than one or two bones) present, which can be taken as possible evidence of dog consumption. The first, Urourina at Yule Island, has charred dog bone from a variety of body parts, and the other, Rainu, has fragmented dog bone throughout the midden. The excavator suggested alternatively that this might be evidence of dogs eating bones, including from their own species. Several sites contain highly fragmented and scattered animal bone attributable to consumption of bone by free-ranging dogs or pigs, but probably dogs in the absence of signs of rooting which would be expected if free-range pigs were present.

The archaeological evidence of dog in the Highlands is similar to the Lowlands, with small quantities of canine teeth in deposits relating to the last 5000 years or less. The exceptions are Kiowa, where a mandible was found in a layer dating to less than 4820 BP, and Mapala, where a dog skull was present associated with deposits, the earliest of which were dated to ca. 5440 BP. Dog teeth have been found in four sites, one disturbed and two with deposits dated to <770 BP and <1200 BP. In the fourth, the deposits were dated to later than 5000 BP. Although these are imprecise dates, they leave open the possibility that dogs were in the Highlands by ca. 5000 BP, as suggested by the Lowlands dates. It can be expected that dog would have spread rapidly throughout New Guinea once it had arrived; the oft-cited evidence that the fox crossed Australia in 70 years (Mulvaney and Kamminga 1999:260) should be kept in mind. Some colleagues have observed that this problem should be solved by radiocarbon dating these dog teeth, but major problems with dating teeth make this inadvisable in my opinion. Better dating of the deposits is not an option in some cases, and what is needed is more archaeological work with the question of the dog in mind.

It is notable that the evidence of dog in the Highlands and the Lowlands is similar, in that dog is found in relatively small quantities, in about half the sites with fauna. Wherever it is found it consists of a tooth or two, or a mandible, or a skull. Other evidence of dog, such as gnawing, fragmentation or scattering of bone, have not been recorded in rock-shelter and cave sites in the Highlands. On the other hand, dogs could have raided these sites for larger bones and carried them elsewhere, as there is little large bone at the sites. The lack of dog bone in faunal deposits in the Highlands sites indicates that dogs were not hunted as food, although they could have been taken elsewhere to be cooked and disposed of. For the present, the available archaeological evidence in the Highlands does not indicate dog consumption, contrasting with the rare possible evidence at the late-Holocene sites in the Lowlands.

New Guinea singing dogs and Kalam dogs

The above review indicates an absence of firm archaeological evidence for early dog in New Guinea, but it is apparent that dogs were present in New Guinea before the Lapita settlement in the Bismarcks. New Guinea singing dogs, the wild dogs of the high mountains of New Guinea, are part of the traditional way of life of the Highlanders (Majnep and R. Bulmer 2000) and they have featured in written records since at least 1897 (Titcomb 1969:60–66). The following section reviews knowledge about these dogs, which feature in origin myths of Highlanders. An example was told by Irian Jaya Highlanders (Larson 1987:48):

> "There were only two domesticated animals: the dog (a variety of dingo) and the pig. Dogs emerged first, sniffing their way through the Seinma crevice and leading the first people on to earth. Pigs followed the first people… Because dog led man up on to earth, and because it has since then guided him through the forest to find new areas in which to settle, it is not killed or eaten as is the pig."

Observers have differed in whether they consider singing dogs to be similar to the Australian dingo. Until the 1950s scientific knowledge was based on few field observations and on museum specimens, not on living examples of the wild dogs, but in 1956 two singing dogs were acquired by Taronga Zoo in Sydney, and this began systematic behavioural and biological studies of them. Singing dogs may have once populated all of New Guinea, but now most Lowland dogs are likely to be domesticated and live in human settlements. However, recent study has shown that singing dogs are still present as remnant populations in at least five high-mountain districts of the New Guinea Highlands and West Irian (Brisbin et al. 1994:35) and some are also still found in forested areas closer to human habitation (Majnep and R. Bulmer 2000). There were also wild dogs in recent times in parts of the Lowlands (Titcomb 1969:66–73), and in the interior of larger islands to the east of New Guinea, such as Umboi (Siassi) (Harding 1967:51) and New Britain (Chowning pers. comm.), probably wherever there was sufficient uncultivated land to support wild animals.

The New Guinea Singing Dogs are so-named by Papua New Guineans because of their propensity to yodel like Highlanders rather than to bark. Although some writers have objected to this name, I will follow its use as it is already widespread in the literature, as is NGSD, its acronym.

Although the singing dog is related to the Australian dingo (Matisoo-Smith 1998), it is useful to retain the name dingo for the Australian lineage, to distinguish between them. While acknowledging that they belong to a common lineage, the particular historical and geographical relationships between dingo and singing dog are not at all certain. In fact, 'dingo-like' dogs were widely distributed around the world and their similarity is thought to be due to their common late-Pleistocene wolf ancestry (see discussion below), not to any direct historical relationship.

The lack of agreement about the biological taxonomic description (Koler-Matznick et al. 2000:239) reflects the lack of clarity in their presumed ancestry. Some consider the singing dog a separate species, *Canis hallstromi*, while others variously have considered it a subspecies of dingo, *Canis dingo hallstromi*, a subspecies of wolf, *Canis lupus hallstromi*, or a subspecies of domestic dog, *Canis familiaris hallstromi*. It is suggested here that the general archaeological/zoological usage be followed (Corbet and Clutton-Brock 1984) which identifies a domestic animal as a separate species clearly distinguished from its parent species, but discourages the use of subspecies to distinguish between races and breeds. Under this convention, the dingo and singing dog are regional races or breeds of the domestic dog. Subspecies are not used for discriminating variants of domestic species in view of the fact that it is the animal's relationship to humans, rather than 'natural' biological/genetic change, that is primarily responsible for its redistribution and changed physical characteristics.

Much of the current knowledge about the singing dog comes from the study of about 100 captured animals in zoos and private collections around the world, the progeny of five dogs from four districts (Koler-Matznick et. al. 2000). There has so far been only one zoological field study of a wild population, in the Star Mountains (Bino 1996). This study indicates that these animals live on a variety of food, including wild fruit and nuts and small prey freshly caught, but a significant proportion of their diet is scavenged from other animals', such the Harpy Eagle's, left-over catches. In other observations of singing dogs, such as those, already mentioned, on the expedition to the Carstenz Mountains of West Irian (J. Hope 1976), the dogs were frequently observed even in the highest unglaciated mountains. Populations of singing dogs are depleted and reports emphasise that they are endangered, with the reduction of habitat and prey due to pressure from expanding Highlands human populations threatening their survival. Although some singing dog populations are thought to have admixture from introduced domestic dogs, certain of the more remote Highlands populations are thought to have remained discrete. As well, it is argued below that the kind of semi-domestication that singing dogs have with Highlanders has served to reinforce their separate biological character.

Although many accounts of the singing dog assert that they are not at all like the dingo, as the evidence accumulates it appears that it is indeed very much like the dingo. Morphologically and behaviourally, the singing dog is very similar to the dingo, although it is considerably smaller, and tends to be more slender and shorter in the leg. The NGSD is a classic example of the early domestic dog (Clutton-Brock 1995:14), commonly referred to as the 'general' dog, which is considered to be a domesticated wolf. It is smaller than the wolf, with a shortened face, and a specialised carnassial molar (Corbett 1995; Gollan 1985:439), although it does not have the typical tooth crowding of the 'general dog' (Koler-Matznick pers. comm.). The NGSD, like the dingo, is strongly sexually dimorphic, highly adaptable to different living conditions, although in recent times is found in a more restricted range of ecological habitat due to the replacement by agriculture of most forest zones. Singing dogs are similar to dingos in appearance: they have prick ears, are short-haired (except for those that live in the highest mountain areas, which have thick winter coats) and have two colour phases, the commonest being tan/russet with white points, and black with white points the less common alternative. They are nocturnal and shy, hunt alone or in small family groups and, on the basis of the only field study so far, are predominantly scavengers, but also hunt small animals and feed on forest fruits and nuts in season.

The singing dogs that survive primarily as wild populations have a different kind of semi-domestic association with humans than dingos with Aborigines, which were kept in some numbers as pets, blankets and guard dogs. This can be seen as a general cultural difference. Aborigines were hunters and foragers themselves and did not generally need to use dingos as hunting assistants, but instead encouraged them to fend for themselves. In contrast, the NGSD associates with Highlands agriculturalists involuntarily, being captured as pups. Humans do not primarily occupy the same territory as the dogs in the Highlands, but venture into the dogs' territory to hunt and travel. The assistance of singing dogs in hunting is achieved by capturing pups and taming and training them. This relationship is important as Highlands hunting is mainly in closed forest where dogs are useful in seeking, treeing and holding animals. Singing dogs were also pets, but their primary function was as a working dog. They were sometimes eaten by humans, but this was by no means universal, and many Highlanders do not eat dogs, some even considering it highly offensive. It can be suggested that the eating of dogs was a relatively recent introduction in the Highlands.

In the 20th century Highlands communities generally kept relatively few domestic dogs, but there is considerable variation in their relationship with dogs, which is beyond the scope of this paper. However, it is suggested that singing dogs in some Highlands societies are used as semi-domesticated hunting dogs, and this may reflect a long-lived relationship. The most detailed accounts of such Highlands hunting dogs concern dogs kept by the Kalam of the Kaironk Valley (R. Bulmer 1976; Majnep and R. Bulmer 2000; R. Bulmer and Pawley 2000). The Kalam evidence is also supported by other briefer accounts of nearby groups in the Bismarck–Schrader Mountain area (Clarke 1971:86; Healey 1990:185). Accounts of other Highlands societies, including Enga, Melpa and Chimbu (R. Bulmer 1976:182), report the eating of dogs, although dogs are sometimes totem animals and treated ritually, rather than as domestically consumed sources of meat.

The Kalam have very few dogs, although dogs figure importantly in their mythology. They have a prohibition on eating dogs, as they consider them unclean feeders. Dogs eat refuse in and around the homesteads and sometimes even break into graves. As a consequence, dog blood and bones are viewed as polluting to humans and harmful to taro, the most important crop. A man must stay away from his taro gardens for a month if he kills or buries a dog or handles a dog giving birth to puppies. The Kalam keep their dogs as pets and hunting assistants, and they are the personal property of particular men, but are not usually bred. In hunting, their role is to expose the prey for the hunter to kill. Kalam dogs originate from the wild, and are captured as pups and raised under controlled conditions. The Kalam in 1976 kept only about a dozen dogs in a human population of about 700. More dogs used to be kept by the Kalam, but they say that this was before poultry-keeping became common, since they consider dogs incompatible with domestic chickens.

Thus the Kalam dogs were not fully domestic in the sense of living their full life cycle under the control of humans. The source of dogs was primarily the wild-dog population, and they were not usually bred in the homestead. Other dogs were sometimes acquired from people in the Lowlands and from visiting Europeans, but it is said that non-Highland dogs did not last long. They are not as good at hunting, and thus feeding themselves, and they tend to be unhealthy in Highland conditions. Serious hunting dogs are fed to some extent so they are willing to give up the prey they catch (see R. Bulmer and Menzies 1972:Table 3 for a sample of animals brought in by hunting dogs). Dogs were sometimes traded as pups, with the singing dog type the most favoured variety. Dogs were also important to the Kalam as sources of teeth for one of the most important 20th-century valuables, necklaces made of dog incisors and canines.

Dog bone is treated quite differently by the Kalam to bones of other animals (R. Bulmer 1976:177). Animal bones from ordinary domestic cooking are fed to the dogs and pigs or left at the cooking site, whereas animals ritually cooked at the men's cult house are carefully kept in the house and then disposed of in the forks of tree branches. Such bones are contaminating only as long as they have flesh and blood attached. The Kalam dispose of dog remains in the bush or forest, where they are buried in a shallow grave or left on the ground surface and covered with foliage. They are never buried near the settlement so as not to contaminate humans and pigs, and therefore gardens. A dog that was a particularly good hunter is buried like a warrior, placed on a wooden platform above ground in a small fenced enclosure, and when the bones are clean left in the fork of a tree in the forest, as is done with human bones. A good hunting dog might also have mandible trophies from animals it had caught displayed in its own part of the wall of its owner's house. Thus, the dog bones are not disposed of in the same way as other bones, and they are never put in the household or garden.

The implication for archaeology is obviously that there will be no dog bone in food middens or general rubbish deposits, and the only sign of dogs will be dog-teeth ornaments. These may be relatively ancient, possibly relating to the advent of maritime coastal trade reflected by the ca. 5500 BP communities on the shores of the Sepik–Ramu inland sea. Direct evidence of dogs might be found in their dens and nests, but the poor survival of bones in tropical New Guinea makes this unlikely. Thus, tiny scattered fragments of bone that suggest the presence of dogs in late-Holocene sites are not likely to survive many millennia, nor are the dogs' coprolites.

Another implication is the long-term survival of the singing dog through passive human protection. They are not eaten, but are valued as a resource of pups for training as hunters, for trade and for teeth. They dwell, not in the human agricultural landscape like the pig, but in their hunting and foraging landscape, which is modified by human exploitation in plant and animal life, and this influences the resources. If this model is valid, it may explain the kind of association between humans and the earliest 'domestic' dogs, that is, dogs that exhibit modified size and morphology as a result of association with humans. But the 'wild' dogs are not 'feral', that is, they are not domesticated dogs that have escaped but inheritors of what may be a very ancient kind of association with human hunters and foragers, and eventually agriculturalists.

Discussion

A review of the evidence from 25 archaeological sites in five regions of New Guinea shows that dogs were widespread, with dog bones and/or teeth occurring in about half of sites that contain bone refuse. However, in quantity there is very little, with the exception of two coastal sites, Urourina and Rainu, where fragmented dog bone was found in some amount, which might reflect the eating of dog. This is only conjectural, but it can at least be said that this evidence contrasts with the evidence at all other sites where dog has been found, and this may be significant. The dearth of evidence for dogs in archaeological sites may be a matter of sampling, considering the limited archaeological investigation in most districts, the small scale of most archaeological investigations and the lack of attention to detailed analysis, or at least reporting, of faunal collections. In view of the lack of detailed analysis of animal bone from some sites, other than species identification of cranial bone and teeth, the presence of dog bone may be under-reported. The interpretation of the evidence is complex and it certainly should not be taken to mean, that in earlier times people kept very few dogs and that is the reason for few bones and teeth. This may have been true, but given the present evidence we do not know this, and in view of our understanding of dogs, it seems very unlikely.

In particular, the absence of dog from sites should not necessarily be taken as proof that dog was not present, and the Kalam beliefs and practices warn against this. The most common archaeological evidence of dog, the perforated canine tooth, is a case in point. The dog canine is known through countless ethnographic descriptions to have been used widely as a component in personal ornaments, either in necklaces or as individual items in composite ornaments. This use of dogs' teeth implies a special symbolic relationship between dogs and humans. Dogs' teeth not only adorn the living but feature prominently in late-Holocene burials and trade on the Papuan coast. The earliest evidence of dog-tooth ornaments so far is at sites of long-distance trading communities on the shores of the Sepik–Ramu inland sea ca. 5500 BP. Unpublished evidence from Lapita sites suggests that dog-tooth ornaments were also used in the Bismarck Archipelago, and the southern Papuan sites indicate continuity of use into post-Lapita times. In recent times in the Highlands, dog-tooth ornaments were one of the most valuable items of trade, comparable to pigs and the fine quality axe-adzes of the Jimi and Wahgi valleys. The antiquity of this ornament in the Highlands is uncertain; perforated dog canines have been found in dated context at only four sites, at three of which the deposits with dogs' teeth are dated to less than 1200 BP, and at the other the layer with dogs' teeth is broadly dated to sometime within the last 5000 years. The latter could, of course, be as recent as the others, but the imprecision leaves open the possibility that the Highlands perforated dog canine ornaments began as early as they did in the Lowlands. However, the rarity of perforated dogs' teeth in sites in the Bismarcks, the Lowlands and the Highlands shows a widespread pattern and may be taken to suggest their considerable history as a highly valued ornament, rather than that they were uncommon and unimportant. The more valuable they were, the rarer dogs' teeth can be expected to be in archaeological sites, with the exception of human burials.

In contrast, the small amount of dog bone in kitchen middens can be considered as reflecting the small quantity of dogs eaten. The absence of dog bone in sites with evidence of hunting and cooking, together with ethnographic evidence suggesting that dogs were not eaten, may be taken as provisional evidence that dogs were also not generally consumed in the past. The presence of dog bone in only two Lowland sites, both dated to the last 1000 years, may be taken as provisional evidence that the eating of dog may be relatively recent in Lowlands New Guinea. However, dogs may have been ritually cooked and eaten, as occurred in some Pacific Islands, and their remains disposed of elsewhere. In any case, it is clear that the New Guinea data contrast significantly with evidence found at sites where dogs are known to have been raised for their meat. An example is New Zealand, where dog bone comprised a large proportion of animals identified in middens and the nutrition of domestic dogs appears to have affected their morphology (Clark 1997a, b; Smith 1996). In sum, on present evidence the eating of dog in New Guinea may have been a relatively recent practice, perhaps occurring in only a small number of communities, and there is no indication that it ever occurred on a large scale.

Other evidence of dogs, including coprolites and gnawed and fragmented animal bone, has been reported at only a few sites. In the absence of direct evidence of dog bone or teeth, this kind of evidence can be useful in the interpretation of the occurrence and function of the dog. Dogs are often a significant agent in the redistribution and destruction of bones on sites (Kent 1981; Walters 1984). Dog burials are also informative, and although so far only a single dog burial has been excavated in New Guinea, it is likely that others will be found, given their prominence in nearby countries, such as in Thailand Neolithic sites (Higham 1975; Higham et al. 1980) and in Australia (Pardoe 1996).

The archaeological evidence of dog in New Guinea can usefully be compared with evidence from Southeast Asia and Indonesia, the countries to the west from where the New Guinea dogs presumably originated. This is a complex subject beyond the scope of this paper, but a few remarks can be offered to begin the process of comparison. Dogs probably depended on humans to reach New Guinea, being strong but unenthusiastic swimmers and given the 100 km or more sea gap between New Guinea and the islands to the west. This contrasts with the pig, which is likely to have sometimes travelled to New Guinea by itself (Bulmer 1998). This means that dogs need not have come from nearby islands, but could have accompanied long-distance voyagers, settlers and visitors from a number of different places and at different times.

The singing dog appears to reflect the earliest dogs to arrive in New Guinea, although there is as yet no archaeological evidence for this. However, the origin myths, their wide distribution, and their wild populations support this suggestion. As mentioned above, the singing dog and dingo share genetic origins identified in their DNA, but whether they came from the same place or from different places, is still unknown. They are descended from wolves, as shown by their DNA, but there are no Southeast Asian wolves, and their ancestors are likely to have been one or both of the two nearest subspecies, the Chinese wolf, *Canis lupus chanco*, and the Indian wolf, *Canis lupus pallipes* (Gollan 1985). As far as I am aware, there are no reports of nearby Southeast Asian early domestic 'general' dogs, such as have been found in archaeological sites in many other parts of the world in the period 14,000–10,000 BP (Clutton-

Brock 1995:10–15; Olsen 1985). However, it is assumed that such an ancestor will be found for the dingo and the singing dog, which are considered to be "ever dwindling, living purebred relics of the first domestic dogs to inhabit southern and eastern Asia in the early prehistoric period" and could have been brought to Australia and New Guinea any time in the last 10,000 years (Clutton-Brock 1995:14). Thus, from the present perspective of Southeast Asia, it is likely that NGSD arrived in New Guinea perhaps by the end of the Pleistocene, and at least by the early Holocene, substantially before the early Thai domestic dogs, at ca. 5500 BP, based on their morphology (discussed below). From a wider perspective, based on recent DNA studies of wolves, domestic dogs, coyotes, *Canis latrans,* and jackals, *C. aureus, C. mesomeles* and *C. simensis,* the domestication of the dog may have begun much earlier, possibly ca. 135,000 BP, and have been more complex than has been thought (Vila et al. 1997). This study suggests domestic dogs may have interbred with wolves or with other canids, and Southeast Asia looks like an interesting area in which to examine this idea.

There are no signs of dogs or other canids in the eastern islands of Southeast Asia, the islands nearest to New Guinea, before 4000 BP (Bellwood 1997:37, 116). However, there is a wild dog, the red dog or dhole, *Cuon alpinus,* in mainland Southeast Asia, and the Sunda shelf and its islands and the golden jackal, *C. aureus* (Clutton-Brock 1984:Fig. 22.2; Groves 1985). The red dog is a widespread Pleistocene species, found in southern and eastern Asia, and as far north as Manchuria and in Europe. It is considered to have a separate origin to the other canids, and is not considered to be an ancestor of the dingo/singing dog. However, the red dog and the jackal may be expected to have influenced the distribution and development of dogs. As far as I am aware, the only archaeological evidence of the red dog is at the Madz site in southeast Sabah in deposits dated to 11,000 BP (Cranbrook 1988:147). It is suggested that the red dog appears to have been generally replaced in Southeast Asia by domestic dogs within the last 4000 years (Bellwood 1997), although it still remains in some relic populations in unpopulated areas and offshore islands.

A possible direct relationship between New Guinea and Southeast Asian dogs can be suggested for the mid-Holocene dogs in the Ramu Lowlands sites, discussed in this paper. The earliest archaeological evidence of domestic dogs in Southeast Asia so far is in Thailand, at Non Nok Tha, where dogs were buried with humans from ca. 5500 BP (Higham 1975; Higham et al. 1980). These Thai dogs are descended from wolves according to DNA analysis (Matisoo-Smith pers. comm.) and they are morphologically half-way between dingos and the modern pariah dog (Higham et al. 1980:59). It is possible that the Ramu dogs of the same period may be related to Thai domestic dogs, as they were found on sites associated with long-distance maritime traders, who were in touch with Southeast Asia and the Bismarck Archipelago (Swadling 1996, 1997).

Another likely source of New Guinea dogs is the modern town and village dogs of Southeast Asia, commonly referred to as 'pariah' or 'pye' dogs. These are thought to be related to dogs that are widely present across Southern Asia, and their primary function seems to be to keep the village clean of rubbish as scavengers (Fox 1984:122–130). Some town dogs are wild, others are individually owned and fed, but all are scavengers. Similar dogs are kept as domestic and hunting dogs in villages of Southeast Asia, where they are individually owned and kept domestically. In some places dogs serve as sources of meat, such as in Thailand, and are sometimes referred to as 'pariah/table' dogs (Groves 1995:161), but I am unsure how widespread the eating of dogs is. Perhaps the situation is similar to New Guinea, where a few dogs are eaten in some communities, but dog flesh is not necessarily a common food. Some authors suggest that some pariah dogs are similar in appearance to red dogs (Davidar 1975), but others report that pariah dogs are highly varied in size, colour and shape (Ripley 1964), and Titcomb (1969:80) describes them as having long muzzles, narrow heads, upstanding ears, and being black and white, or some shade of light brown or a combination of these colours. Titcomb (1969:77) and Groves (1995:161) both think that the Pacific dogs come from pariah dogs, but this is not consistent with the DNA and morphological evidence, which shows the Pacific dogs belong to a separate lineage. It also implies a different and simpler explanation of the history of New Guinea dogs, that dogs arrived relatively recently and that wild dogs are feral dogs of domestic origins.

This suggested history needs to be set aside now, as it did not of course have the benefit of the available archaeological evidence described in this paper, which suggests multiple origins for New Guinea dogs over a much longer period. While the pariah dogs no doubt found their way to New Guinea, there are other strands in the story. Aside from the singing dogs and the early domestic dogs, Lapita potters brought dogs to New Guinea, and they could have been dogs of a different breed or breeds, given the posited history of the Austronesian-speaking peoples and their migration from Formosa through the Philippines. This might account for the Pacific dog lineage, already mentioned, and these might be the dogs that appear in the islands of eastern Southeast Asia after ca. 4000 BP. There is also an archaeological hint of other sources of dogs in the little domestic dog at Niah that in relatively recent times preceded the pariah dogs (Clutton-Brock 1959). Repeated contacts by maritime traders in Southeast Asia could have seen the distribution of small numbers of domestic dogs from many sources as gifts or trade items. This suggests that the history of dogs in New Guinea is probably closely related to that of Southeast Asia, and is probably more complex than contemplated at present; we no doubt have much to learn.

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Earth mounds of New Hanover, Papua New Guinea: distribution and function

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Introduction

It is often hypothesised that agriculture played an important role in the Lapita dispersal, although no agricultural sites, of Lapita or post-Lapita age, have yet been adequately studied in the Bismarck Archipelago. A series of mounds have been identified in New Hanover whose significance to understanding prehistoric agricultural systems has not passed unnoticed (Hide et al. 1996:31). This paper reviews the previous reports of mounds in the New Hanover region, presents the results of a recent mound survey, and proposes that agriculture may have been the primary function of the mounds.

Background

Earthworks associated with prehistoric agriculture have been identified throughout mainland Papua New Guinea in both the highlands (Allen 1970) and the coastal lowlands (Hitchcock 1996). They consist primarily of what have been interpreted as raised gardens and drainage ditches. The New Hanover mounds are distinct from those of New Guinea in that they are linear (often rectilinear) earthworks with a semi-circular cross-section. Previously, the term 'mounds' has been utilised to represent a variety of earthworks including short earthen piles or hillocks. For the purposes of this paper the term 'mounds' will be utilised to represent linear earthworks only.

In New Hanover, mounds were first reported in 1957 after a Patrol Officer visited the villages of Patipai, Patiagaga and Bolpua (Fig. 1). The residents of these villages had gardens in the headwaters of the Timor River of which it was suggested that:

> "this area was once the site of extensive gardens years ago. This was proved because of the existence of the old mounds of earth which surround the gardens and are characteristic of the Lavongai people. These mounds of earth are built surrounding all gardens in the form of a fence or terrace. The mounds are generally three or four feet high and a couple of feet wide. This practice was more widely followed in the past but the practice is dying out now, as the people don't really know why they do it. This fact has not been noted in any other area of New Ireland" (Cochrane 1957:20).

Similar evidence of 'old' gardens was also noted at Meteas on the Butei River (Cochrane 1957:20). Lampert (1966a) reported mounds at a number of additional locations in New Hanover. They were identified up river from Noipous village in northern New Hanover. The local villagers believed the mounds to be associated with old gardens (Lampert 1966a). Mounds were also reported on Mussau (Spriggs 1982:313), although Spriggs (pers. comm.) now feels that the report might refer to New Hanover, and on a nearby island in the Tigak group known as Selapiu.

> "On the north-west slope of the main hill, low earth mounds enclose rectangular areas. One such rectangle is 15 × 40 m with the short axis parallel to the contour. The enclosed areas have a fairly steep slope and the pattern is thus unlike the terraced hillsides associated in other parts of the world with rice growing. Mr E. Lauder, the present manager of Selapiu Plantation, says the mounds cannot be explained by European activities" (Lampert 1966b:5).

The Papua New Guinea Museum site register contains a 1970 report by a plantation manager named Randolph on mounds at the Benge Plantation, on the south coast of New Hanover. They were described as: "earth mounds arranged in geometric shapes about 1 m high, and more or less like low walls or rice paddies". Randolph suggested the mounds were adjacent to most villages throughout the island. They could also be seen in food gardens and in secondary forest (Swadling 1991:554).

Paul Gorecki and Patrick Kirch visited the mounds at Lavongai village in 1985 and noted:

> "The entire valley floor behind the beach has evidence of a peculiar prehistoric garden system. It consists of low ridges encircling 'ponds'. The system covers many hectares if not a few square kilometres. It is huge. Kirch's reaction was that it looked like a prehistoric copy of contemporary Futuna taro ponds. We do not know if the system was irrigated, but it is a strong possibility. Surface visibility is outstanding (mapping the system should be easy) and recent drainage carried out by the Mission should greatly help the recording the basic stratigraphy of the basin. On the spoil heap of a recent 10 m long drain we found three chert flakes, charcoal and one well preserved piece of wood. This suggests some depth of deposit and outstanding organic preservation" (Gorecki 1985:22).

Mounds were also reported at Meteran (Hide et al. 1996:31). The descriptions represent a variety of sources and locations across New Hanover and the adjacent Tigak Islands. The similarity of the descriptions and the distribution of the sites suggests that mounds were widespread throughout New Hanover. A common feature in the previous accounts was the suggestion that the mounds were used for agriculture.

Survey

In 1999 a survey was undertaken to, first, determine if the mounds were as similar as the descriptions suggested and, second, to discover how widely they were distributed. The survey was designed to sample a wide variety of landforms including alluvial and coastal plains, inland valley systems, ridge tops and coastal hills, as well as inland hills and mountains. The survey also included the north and south of the Tirpitz Range that runs east–west across New Hanover.

Six previously unrecorded mound sites were identified at Butielung, Baungung, Narim, Niekonomon, the Upper Ungat and Woi river valleys (Fig. 1). For the purpose of this paper, they have been grouped into coastal and inland sites.

On the west coast, mounds were identified at two locations. At Buteilung, they were on the alluvial plain between the main village and the coast and were less than 1 m in height. Some of the mounds coincide with modern garden boundaries but this was not always the case. At Baungung, the mounds were located in a well-maintained coconut plantation and were therefore highly visible. The plantation was on the western bank of the Baungung River and the mounds were up to 2 m high and 3.5 m in width at their base. Mangroves surrounded the mounds at Buteilung and Baungung.

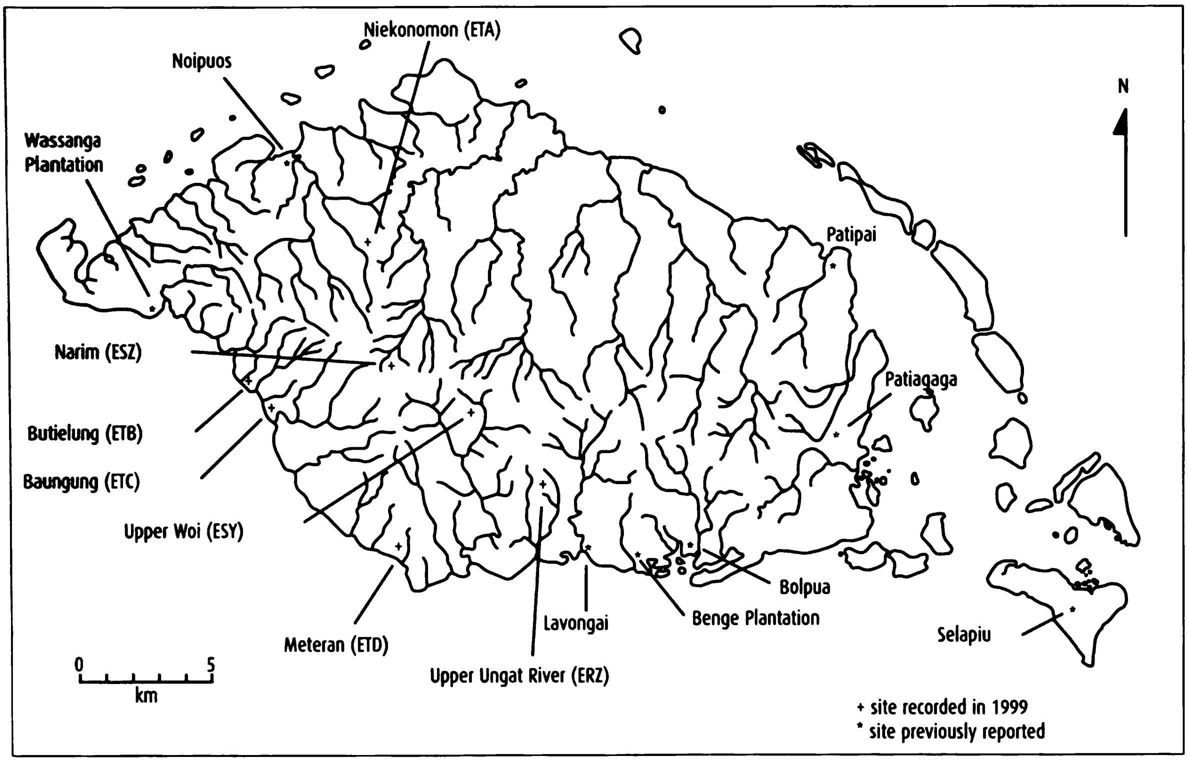

Fig. 1. Map indicating the mound sites on New Hanover.

The inland mounds of the upper Ungat River Valley were used as a makeshift path leading through a garden and extended into secondary forest. While only four distinct mounds were identified, they were spread over a distance of about 100 m and were up to 1 m high. The upper Woi River Valley mounds were more extensive and the individual mounds were larger than those of the Upper Ungat River Valley. They were distributed on both sides of a tributary that ran into the Woi River and occurred in gardens as well as secondary forest and were up to 1.5 m in height. Both the Upper Woi and Ungat River valley mounds were located on low-gradient slopes.

The Narim and Niekonomon mounds were on relatively flat ground. They occurred in both secondary forest and garden contexts although there was relatively less bush around Niekonomon due to the proximity of logging. These mounds were less than 1 m high.

The sites had four general characteristics in common. First, the mounds were all similar in shape. They were linear with a semi-circular cross-section. They were between 50 cm and ca. 2 m high, 2–3 m wide at the base and between 10 m and 40 m long. Second, visual examination suggested that all mounds were made of earth rather than stone. There were two observations that supported this assertion. No stone was exposed on the surface of any of the mounds and a test pit dug in the Lavongai complex encountered little stone. Third, the mounds often joined together to form enclosed 'fields' although the fields varied in shape and size. Fourth, the mounds were located in the bottom of valley systems rather than on hilltops. This included the inland sites of the Upper Woi and Ungat River valleys, Narim and Niekonomon. While the mounds in the Upper Woi were not on flat land they were on land with only the very lowest gradient in the upper reaches of the valley.

There were also a number of relatively minor differences between the mounds. The individual mounds were not all exactly the same in actual size and length as pointed out previously. This may have been due to differential design or preservation. Baungung has the largest mounds and they were located in a well-maintained coconut plantation. By contrast, the Upper Ungat River valley mounds were in a less stable garden environment and were smaller and less consolidated. Second, the actual 'fields' were of different shapes both within a single site and between sites. Third, they occurred in different environmental zones. Mangroves surrounded the sites at Butielung and Baungung while the inland sites of Niekonomon, Narim, the Upper Woi and Ungat Valley were surrounded by secondary rainforest. Fourth, there were differences in visibility at each of the sites. The sites located in areas presently being utilised for gardening were more visible than those sites in secondary rainforest.

Despite these differences the survey showed the mounds to be very similar in general character throughout the study area. The similarity between the sites suggested they may have been designed with a similar function in mind. The Lavongai village mounds were selected for closer examination for two reasons. First, the relatively good visibility (Gorecki 1985:22) and, second, the site was located in a geographical context that had been suggested as a probable site for early agriculture. The mounds were located on an alluvial plain adjacent to a side stream before it intersected with the Marsaula River rather than adjacent to the river itself (Kirch 1975:176; Spriggs 1985:427).

Lavongai mounds

Lavongai is the largest village on the south coast of New Hanover and is situated at the mouth of the Marsaula River. The village is located west of the river mouth along the beach. To the east of the river is the Lavongai Mission, which looks across the bay at the village. Mission grounds extend over the alluvial plain east and north of the Mission. The mounds are located over an area of at least 3000 sq m up the Marsuala River Valley. The mounds located immediately adjacent to the Mission are the subject of the following discussion and can be divided into two main parts, mounds on areas with cocoa trees and mounds on land with no trees (Fig. 2). West of the road and north of the track the ground is predominantly covered by cocoa trees and some coconut palms. East of the road and south of the track the land is used primarily for subsistence gardening and contains some old coconut palms but no cocoa trees. Visibility is greatest in the area containing only coconuts.

The mounds were up to ca. 70 cm in maximum height, ca. 1.5 m wide and varied in length from about 20 to 140 m (Fig. 2). In conjunction with the mounds there was a series of ditches which were mainly located in the area without cocoa trees, but were not as widespread as the mounds. The ditches form rectangles that join the roadside drain and empty into a nearby stream. The stream empties into the Marsaula River at its mouth. The ditches were highly standardised, being ca. 60 cm wide and ca. 50 cm deep. They had clearly cut through the mounds and into the ground below, indicating they postdated the construction of the mounds. Local informants said the ditches were dug by the Mission, suggesting they were in the order of about 100 years old.

What were the mounds for?

Two suggestions have been posited for the purpose of the mounds. The first is that they were boundary markers and the second was that they were for agriculture. Both will be discussed in turn.

Boundary markers

Swadling (1991:554) suggested that similar mounds at Kove, in the Kombe district of West New Britain, and Santa Ana in the southeast Solomon Islands were boundary markers designed to be found again after forest regrowth and soil rejuvenation. While a boundary marker function could not be ruled out for the New Hanover mounds, they were also similar to mound formations found elsewhere which have been described as pondfields. The New Hanover mounds could have had a dual function in the past.

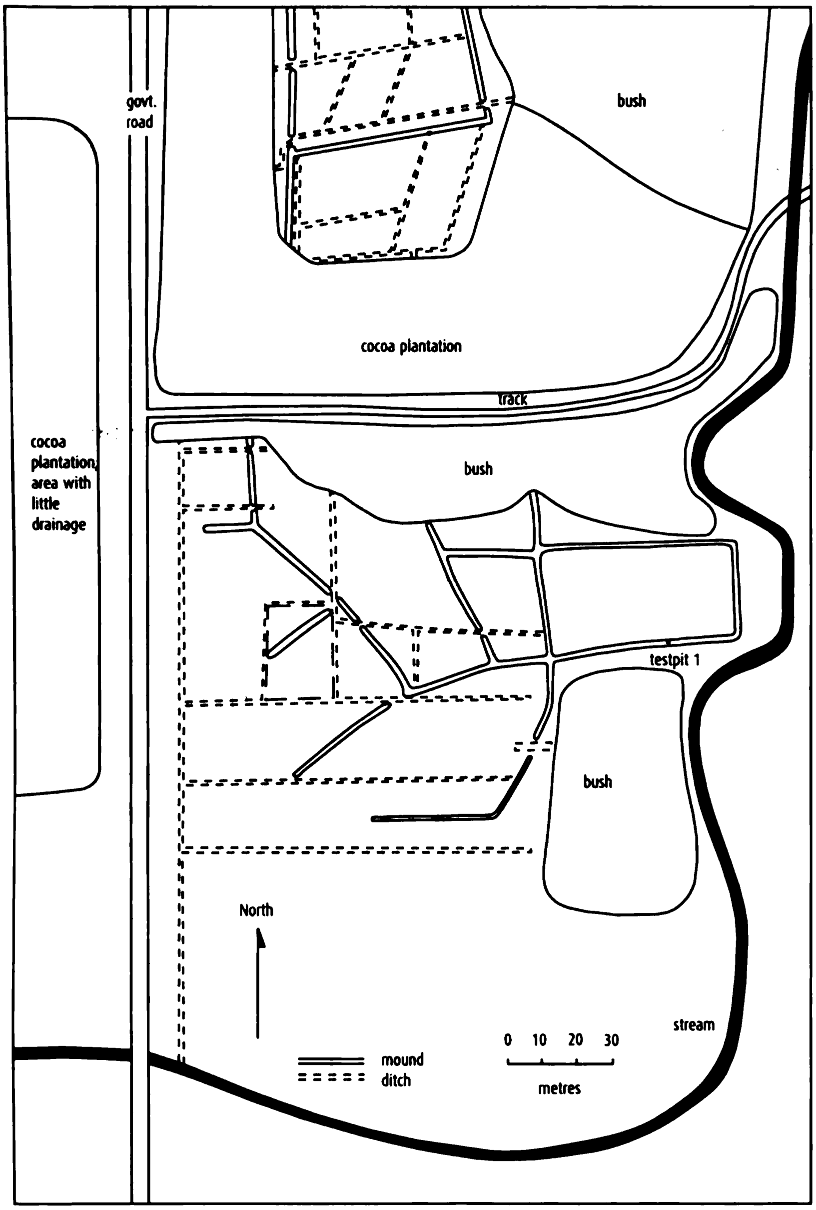

Fig. 2. Plan of the Lavongai mound site.

Pondfields

In order to determine whether the Lavongai mounds might have been designed for agricultural purposes, their attributes were compared to features recorded from pondfield systems on Futuna (Kirch 1994). The comparison will determine how similar the Lavongai mounds are to known agricultural sites.

Pondfields usually occur in valleys with a permanent water source (Kirch 1994:105, 218–219). Stone or wooden walls held up the mounds (Kirch 1984:133, 231). They tend to require channels to bring the water from the stream to the ponds; however, this is not always the case (Kirch 1994:129, 141, 173, 175). Pondfields tend to be large (Kirch 1994:171). The mean area of the average pondfield system at Futuna was 250 ± 207 sq m and some were significantly larger. The mounds must be of a size to hold the required amount of water (Kirch 1994:152). The mounds were connected to form broadly rectangular, enclosed areas. Water was drawn from the stream by a dam (Kirch 1994:137). Pondfields were not necessarily extensively terraced (Kirch 1994:131, 171).

By comparison, there are a number of similarities and differences between the features set out above and the attributes of the New Hanover mounds. First, the New Hanover mounds differed in that they had no indication of construction material other than soil. Wood or stone did not appear to be part of the mounds' fabric. Second, no irrigation channels were identified at Lavongai. However, approximately half of the mounds had ditches cut through them that led to the downstream end of a nearby stream (Fig. 2). The area with the ditches was well drained while the area without the ditches was very damp and muddy. Therefore, it is suggested that the ditches were responsible for draining water and were probably deliberately designed to do so. If the ditches were designed as drains, it may be suggested that the mounds have been designed to accumulate and hold water without any specific input from water channels. Third, no evidence of terracing was identified in New Hanover although this may be altered by further site survey.

The New Hanover mounds were similar in most of their attributes to the Futuna pondfield systems. First, they occurred in valley floors or in flat coastal areas adjacent to rivers allowing easy access to fresh water. Second, the individual mound systems were as large as those identified by Kirch (1994). Gorecki (1985) put the area covered by the Lavongai mounds at ca. 3000 sq m which is significantly larger than Kirch's recorded average. Third, the New Hanover mounds were large enough to hold water. They varied from ca. 0.5 m to 2 m high and from 2 m to 3 m wide at the base. The layout, shape and size of the mounds was also consistent with a water-retention function. The presence of the 'ditches' was an important factor in considering whether the ditches were able to hold water. The area without the ditches was extremely wet indicating that, if it were not for the presence of the ditches, the entire area of the mounds would also have been wet. And fourth, the New Hanover mounds were all located in areas with access to water, although at Lavongai no specific dam was identified.

The general agreement between the New Hanover mounds and the features recorded by Kirch (1994) suggests the former may have been the remnant of a prehistoric agricultural system. If this is the case, it may be possible to suggest what crops may have been grown because the mounds themselves may be suggestive of some, rather than others.

The extensive distribution of the mounds might reflect the nature of the crops that were grown. Some crops have a relatively long maturation period while the gardens require equally long periods of fallow. For example, swamp taro *Cyrtosperma chamissonis* can be harvested three to seven years after planting (Swadling 1981:42). This would result in a long cycle of production/fallow and therefore account for the spatial extent of the mounds across much of New Hanover. The gardens may also have been designed to grow other taro species such as *Colocasia* which have a maturation period of about a year (Summerhayes pers. comm.).

Soil samples have been collected from a test pit dug into one of the mounds. Only the analysis of these samples for plant remains will determine what species were grown at the site. To this end, phytolith and starch analyses are presently under way. Once these analyses have been completed, it may then be possible to consider potential crop yield and population size.

Conclusion

The objective of this paper was to consider the prehistoric function of the New Hanover mounds. This has been achieved by a review of unpublished reports of mounds in the New Hanover region, the results of a site survey and the preliminary investigation of the mounds at Lavongai village. It is accepted that the mounds might have served as boundary markers but it is proposed that the mounds were the remains of a pondfield agricultural system. This can only be confirmed by further research.

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Burial practices at the end of the prehistoric period in Cikobia-i-ra (Macuata, Fiji)

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Introduction

This paper describes the burial practices in use on Cikobia Island (Macuata, Fiji) at the end of the prehistoric period. Cikobia is the northernmost island of the Fijian archipelago, located on the maritime access route to West Polynesia, especially towards Futuna, Uvea and Samoa. The island, about 10 km long and 2 km wide (Fig. 1), lies in open sea around 60 km from Udu Point in Vanua Levu. It consists mainly of uplifted limestone formations, centred on a basaltic outcrop located in the southeast (Derrick 1965). A reef and a small lagoon protect the eastern side of the island, the only part settled today.

The Cikobia archaeological study is part of a research project conducted by a French–Fijian team involving the Museum National d'Histoire Naturelle (Paris, France), the New Caledonia Département Archéologie (Nouméa, New Caledonia) and the Fiji Museum (Suva, Fiji). The general objective of the program, which includes also the study of Naqelelevu Island, is to place the prehistoric chronologies of both islands in the context of the inter-insular prehistoric relationships of the southwestern Pacific. The evolution of the mortuary practices is one of the issues addressed in the program.

The first general results of the program have been presented elsewhere (Sand and Valentin 1998; Sand et al. In press). In short, after the completion of three field-work seasons (1997, 1998, 1999), it appears that the prehistoric chronology of Cikobia can be divided into three main phases. The first starts with the settlement of the island around 850 BC and is related to the regional Eastern Lapita cultural complex. The middle phase corresponds to the spread of the settlement and the first signs of environmental transformation and erosion. The latest prehistoric phase is the richest in archaeological remains, characterised by the development of dry horticultural field systems, pig walls and elaborate settlement areas. It is also marked by the construction of a number of fortifications and special burial mounds. The ceramic chronology, different from the West Polynesia chronology, follows in general terms the three-phase typology known for the rest of Fiji.

Although burials were encountered in the three chronological phases, most of the 25 funerary sites identified in the eastern part of Cikobia are probably related to the recent period. Some can be linked to the local oral traditions recorded during our field seasons and by Biggs (Biggs and Veremalumu-Biggs 1975), like the Navuratau site, which according to oral history was the location of

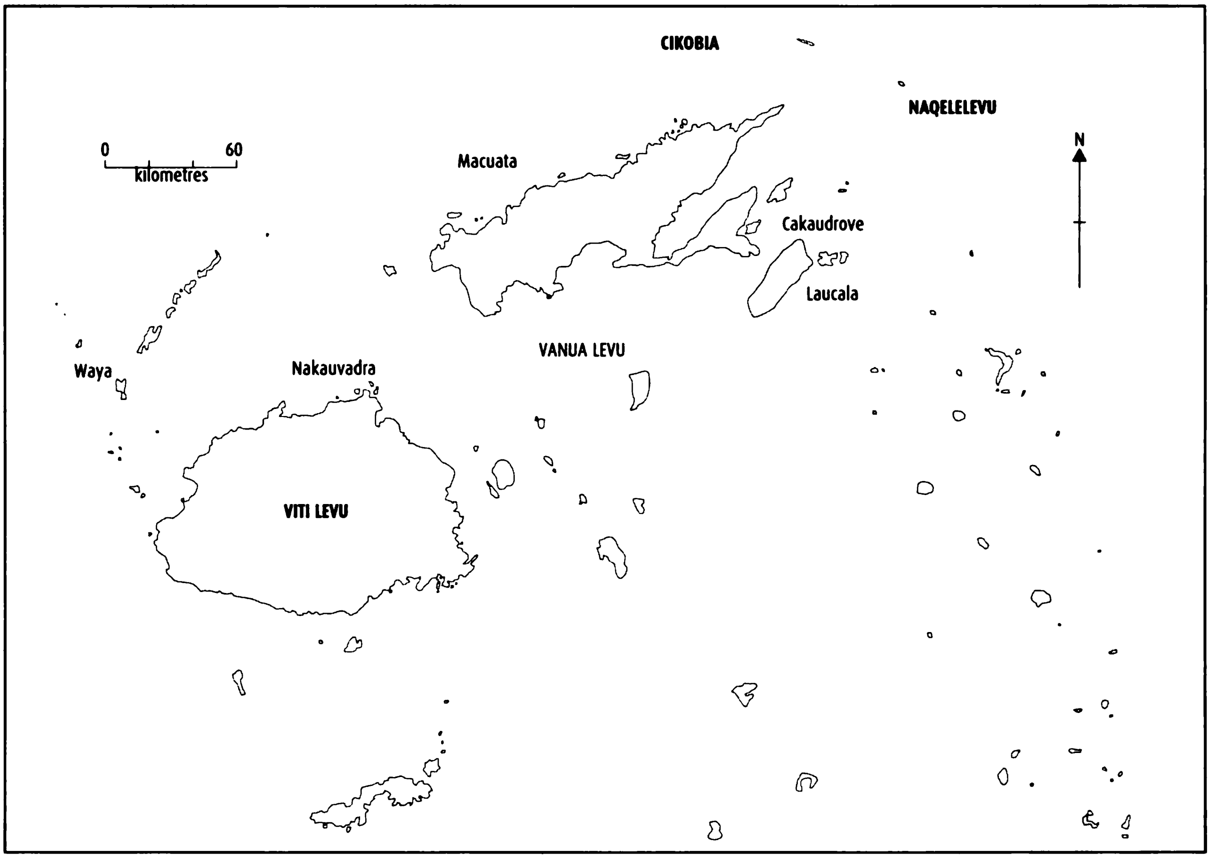

Fig. 1. Location of Cikobia and Naqelelevu in the Fijian Archipelago.

the first settlement on the island. Some rock shelters like the Nabulubulu cave were used as burial places in the late prehistoric period, a local tradition already recorded by Hocart (1952). The majority of the burial sites, isolated graves or graveyards, were recognised during the survey because they consist of oval-shaped structures surrounded by coral and/or beach rock slabs; upright stones are found on some graves. Fifteen of them are burial mounds showing a special mode of construction. They result from the progressive combination of burials, marked on the surface by stone surrounds.

The present paper reports the first results of an excavation conducted in 1999 on one of these burial mounds. After a short description of the construction of the burial complex, it focuses mainly on the funerary practices and sepulchral treatments identified through a detailed analysis of the skeletons' placement and of the taphonomic evolution of the bodies.

General setting

The 15 Cikobia burial mounds were located in different places in the eastern part of the island, near the coast at the back of the beach as well as inland, as in Navuratau for example. Some are located near or around dwelling areas, as in the old fortified village of Korotuku, where three large mounds were recorded. The size and shape of the mounds vary depending on the individual organisation and on the number of graves. They can result from the combination of about 10 burials like in old Vatulele village as well as 50 or more as at Navakarara near Nalele village. They include both coral blocks and beach rock slabs in their construction.

The excavated burial mound, a site labelled CIK037D, is one of the three mounds in the old fortified site of Korotuku. With an area of over 15 hectares, this site is one of the largest Fijian forts mapped to date. It is located on the eastern part of Cikobia on top of the Korotuku hill, which reaches an altitude of about 135 m asl (Fig. 2). Defensive walls were built in areas where the cliff protection was

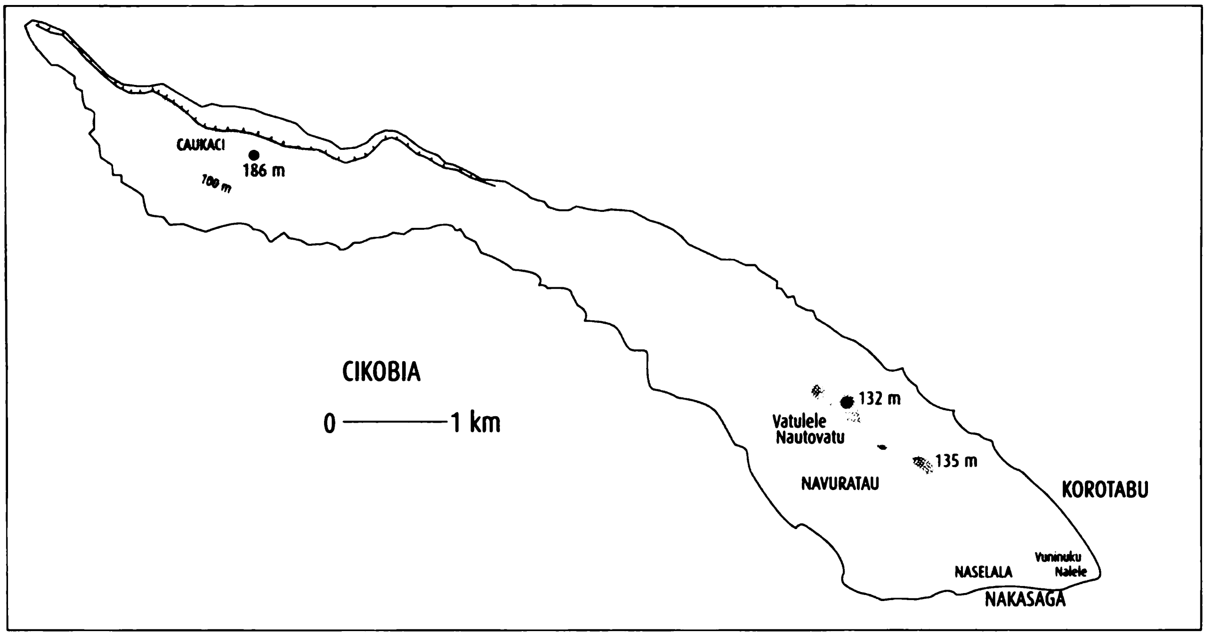

Fig. 2. Cikobia map with burial-site locations.

insufficient. Inside walls, sometimes with a defensive gate, divided the internal area of the fort. Korotuku contains more than 90 structures, including house mounds, burials, possible pig walls and cultivation areas. Although it is difficult to specify the chronological relationship of the structures, it is worth noting that the CIK037D burial mound faces an open area, closed by a large and narrow ceremonial platform about 10 m towards the north. According to the inhabitants of Nautovatu and Vatulele village, this graveyard belongs to *Batinisavu ke Korotuku*. However, no direct oral tradition for the site has been recorded.

Conditions of excavation and methods

Fijian authorities and landowners have endorsed the CIK037D burial-mound excavation under several conditions, including the preservation of the general aspect of the site and of the skeletons; the study of the human remains and other artefacts in the field, and their reburial *in situ* after observations. Such requirements involve a non-exhaustive study and an inevitable loss of data. Removal of bone samples for isotopic and DNA analysis and of European trade beads for provenience analysis was accepted. Three weeks of the 1999 field work were devoted to the study and the further reconstitution of the CIK037 mound by four archaeologists and physical anthropologists helped by two local workers.

First, removal of the vegetation over the total surface of the mound led to the collection of pot sherds, glass flakes, human and animal bones, marine shells and pebbles. A grid of 10 m by 8 m was then projected over the site before mapping. The excavation was done by hand trowel and brush following artificial levels of 20 cm before reaching the human remains. Time constraints and excavation conditions did not allow a detailed study of the sediments fill, which was coarsely sorted to evaluate its components.

Special care was taken exposing the skeletons, using small dental tools and brushes. One of the purposes of the excavation was to assess the process of body decomposition and the extent of joint disturbance. That is the principle followed by French physical anthropologists (e.g. Duday et al. 1990) when defining the taphonomic condition of the human skeleton. Each bone was completely cleared of sediment to record its surface appearance and to specify the status of the articular surfaces in relation to adjacent bones. The extent of disturbances compared to normal anatomical ordering was then assessed for each skeleton to reconstruct the initial position of the body and the grave architecture. Such an approach avoids some common misinterpretations because the position of the skeleton does not always coincide plainly with the position of the body. Misplacements can be minor and can vary with the initial position of the body. For example, a slight flexion or disarticulation of the forearms on the abdomen following loss of body volume. All burials were photographed and drawn.

Biological characteristics of the skeletons were recorded in the field following the usual standards. Relevant for this preliminary study, sex was assigned by the observation of three morphological characteristics of the innominate bone following Bruzek's (1991) method. In addition the cranial features mentioned by Ferembach et al. (1979) were observed. Age at death was determined using the degree of cranial suture closure (Masset 1982); dental wear and eruption patterns; epiphysial fusion sequence; and immature long-bone length.

Construction of the burial mound

Description

Burial mound CIK037D measures about 10 m long by 7 m wide and has an oval shape. It is about 1 m at the highest point. It consists of a combination of individual burials seen on the ground by seven stone enclosures (Figs 3 and 4). All the graves have coral blocks of various sizes, the lateral graves also include beach rock slabs in their construction. A line of four large enclosures (E, D, C, B) forms the median axis of the structure. They have a length of between 3.8 m and 2.8 m and a width between 2.2 m and 1.9 m. They display a north-south orientation. Three structures were placed laterally, one at the northwest (A) and two at the south (G, F). Although having quite similar measurements compared to the median enclosures, they are characterised by a smaller internal space (average 2 m long and 1 m wide) because the internal sides of the wall were faced with beach rock slabs. Four graves (C, B, G, F) are built from others while three (A, D, E) are independent.

The graves share the same mode of construction. On the surface they were identified by an oval of coral blocks which was not superficial but continued beneath the surface, with the wall made of two or three rows of coral blocks. These low walls maintain earth, leading to the formation of a mound. The conception of this burial place reveals a strong cohesion. The burials contribute to the construction of the same mound and the enclosures were set against others.

Some variation was observed despite the strong cohesion of the burial complex. The orientation of the stone arrangements vary: four are north-south (E, D, C, B) and three are west-east (A, G, F). Beach rock slabs, placed vertically against the enclosure inside the grave, were used only in the lateral graves (A, G, F) and in grave B. There is a contrast between the very large graves which have an internal space superior to the needed space and small graves with a barely sufficient internal space. The mode of construction also displays variability. Three enclosures (E, A, D) are complete and four result from the addition of walls lying against the earlier structures (C, B, G, F). This variety could indicate different funerary treatments due to social distinctions or an evolution of the burial practices of the Cikobia inhabitants.

Construction sequence

The sequence of mound construction and use may have been the following. First, the burials E, D and possibly G were made simultaneously (or separately). The mound was built for the preservation of these graves as indicated by the enclosures constructed for each person and placed at each side of the mound. White sand and pebbles were scattered on top of burials D and E. Second, individual 9 could have been buried between the structures E and D. However, this could have occurred at any time during the use of the mound. Coral blocks belonging to grave E were moved to dig the grave and white sand was scattered above burial 9. This layer of white sand was also observed under misplaced coral blocks attributed to burial E, showing further modification of the stone arrangements. Third, building

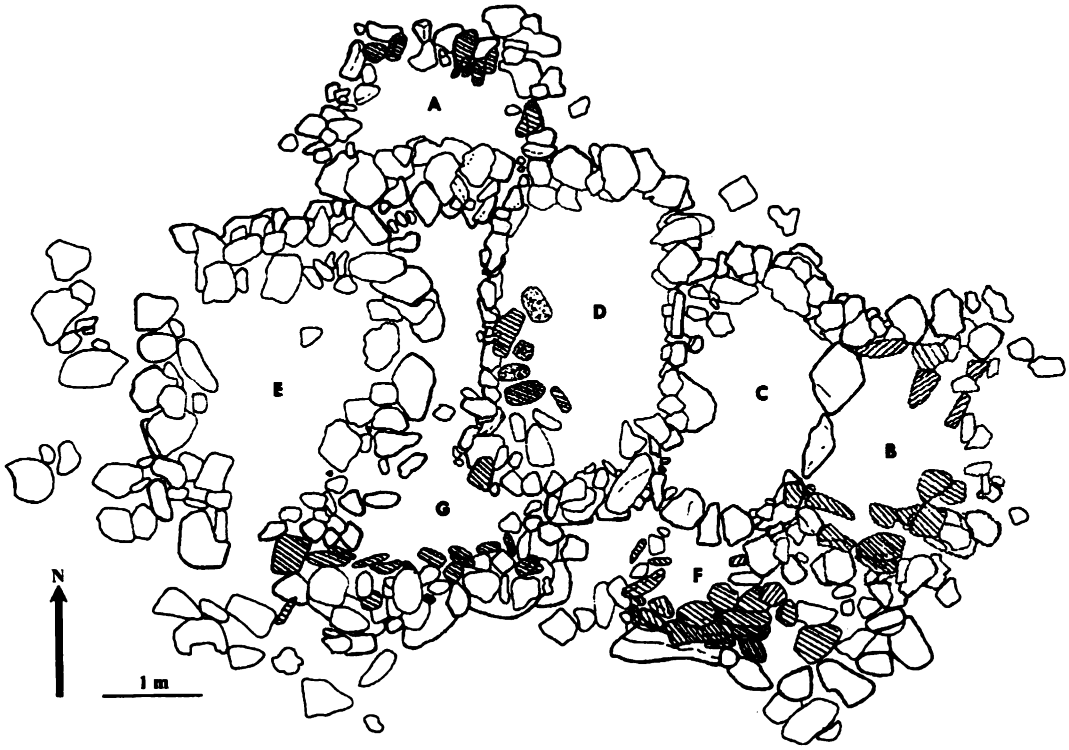

Fig. 3. Map of the CIK037D burial mound.

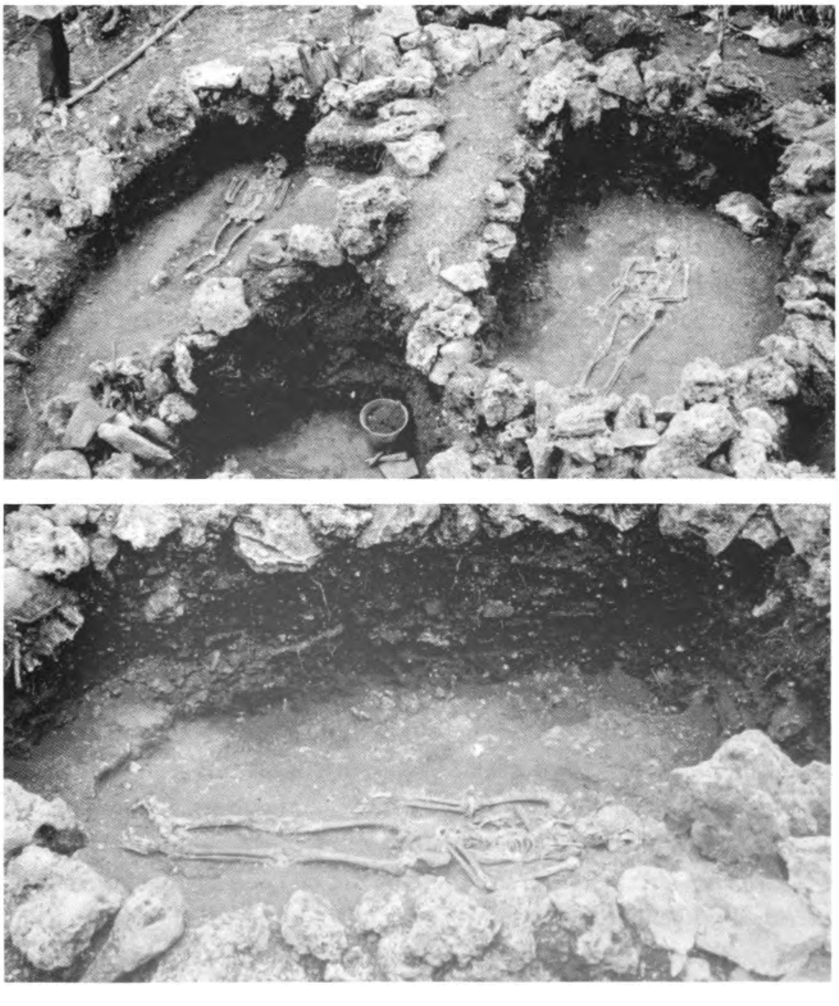

Fig. 4. Top is a view of the CIK037D burial mound with burial E on the left side and burial D on the right side. Individual 9 was found in the space between D and E. Below is a lateral view of burial D.

of the lateral graves A and possibly G at the north and south of the mound, or achievement of the median line by addition of the graves C and B, and building of the grave for burial F. Fourth, the final use may have been the shallow interment of two immature individuals in the top of graves E and G.

This description and the story of the formation of the CIK037D burial mound is quite different from those known elsewhere in Fiji and in West Polynesia. For example, this site is clearly distinct from the burial mounds at the Sigatoka dunes (Best 1989) or those in Tonga (Davidson 1969; Kirch 1988; McKern 1929) and in Wallis (Frimigacci et al. 1984; Sand 1998, 1999).

Funerary treatment

Ten separate interments were excavated from the CIK037D burial mound. They correspond to two immature individuals and eight young and mature adults, amongst which five males and two females were identified by the examination of the pelvis and skull morphology.

The remains of both the immature individuals were recovered in the upper part of two adult graves (G and E). In E the immature skeleton, badly preserved and disturbed, was on the east side at about 30 cm depth. In a probably crouched position, it displays a north-south orientation with the head to the north like the adult skeleton recovered more than 30 cm deeper in the middle of the enclosure. In G, a few fragmentary and disarticulated immature remains were found scattered from 10 cm to 30 cm in the upper part of the grave fill while the adult skeleton was 30 cm deeper. Although both immature interments lacked recognisable pits, they could result from reuse of burial locations, since their positioning is not superimposed directly over the adult in E, and because of a change in the grave fill in G.

Although it does not seem the case in the CIK037D burial mound, it is worth remembering that, in Fiji, the custom of interring one body above another is documented in historical records. On the other hand, such cases were observed at Sigatoka (Burley 1997) and in the post-contact burial site of Navatanitawake in Bau (Parke 1993, 1998). But both cases involved the superpositioning of adult skeletons.

The adult skeletons and bones were fairly complete but poorly preserved. They were very fragile and fragmented *in situ*. Exposure of the skeletal elements had led to some damage through bleaching and fragmentation. But the biological features of the skeletons were recordable. The distribution according to sex does not seem due to chance because the males are mainly in the median part of the structure (E, 9, D, C). Only one male is in a lateral grave (F) while the two identified females are in the small lateral burials (A, G). Adult interments consisted of fairly articulated skeletons in individual primary deposits. No instance of reburied disarticulated bones was found and none of the bones had been removed before burial.

Were the interments in pits?

The CIK037D burials lacked clearly defined pits, but pits were probably dug before the bodies were deposited. Traces of pits were identified in four graves (D, C, B, F) located at the east part of the mound. The digging had cut the coral limestone to a depth of about 15 cm in three cases (D, C, B) and 30 cm in one (F). This work could be related to the general morphology of the mound. In the west part, four individuals (A, E, G, 9) were buried in the mound earth. Pits might have had a regular shape. In six internments, the bone-arrangement analysis revealed a 10 cm rising of the head, the shoulders, the elbows and the feet. This indicates rounded pit junctions between base and sides, longitudinally and transversally as well. Some pits associated with small enclosures had barely enough room for the body (A, G). In addition, in CIK037D the bodies were not directly covered with white sand as described in West Polynesian burial sites (Davidson 1969; Frimigacci et al. 1984; Sand 1998) and in some burials of the ceremonial site of Navatanitawake (Parke 1993, 1998). However, a layer of white sand occurred in the enclosure D and between the enclosures D and E, about 50 cm above the bodies (D and 9). If the sand layer and the body are linked, this could be suggestive of a combination of digging and heaping material up over the body, which is a modern funerary custom in Fiji and West Polynesia.

Pebbles were also found on the surface and in the upper part of the fill grave. Contrary to the pebbles encountered in some Navatanitawake burials thought to derive from the Yasawa Group in Fiji (Parke 1993, 1998), those recovered in CIK037D are likely to have a local source. Pebbles were also noticed in another Cikobia burial site (Korotabu) located on top of an islet on the north coast of the island. In this last case, the pebbles could have come from beaches located on the northwest coast of Cikobia. The existence of pebbles on the surface of burials is also often mentioned in West Polynesia.

Orientation

Both skeletons and enclosures had the same orientation. In the large medial enclosures, body orientation was north-south with the head at the north. The lateral individuals are west-east with the head to the west. According to our observations body orientation does not seem related to sex, but most of the males were lying north-south. Both females had the head on the left side. This feature is consistent in female burials and shows some variety amongst males. Some males have the head on the back (9 and D), others on the left side (E, C) and the last on the right side (F).

The direction of the eyes and head orientation could be a component of the funerary ritual. However, it can be discussed only after a detailed examination of the skull position and of the position of the first cervical vertebra. Such an examination can distinguish the initial rotation of the head and placement resulting from taphonomic process (Duday et al. 1990). Observation of head rotation was made on four burials. It appears that the males have the eyes turned towards the south and the southeast regardless of their location in the burial complex. The head rotation in burial A may not be the initial position but could result from a displacement during body decomposition.

Initial position

The adult skeletons were lying on their backs usually in a fully extended supine position (Fig. 4). There was large variation in upper-limb position sometimes with different patterns for the left and right. Some had both arms (F) or one arm (D, C) parallel to the sides, or folded with the hand on the abdomen (A, D), or crossing the body with the hand on the heterolateral elbow (B). Some had both arms folded (E, 9, G) or the right arm folded (C, B) with the hand on the homolateral shoulder. This last position was the most common in the CIK037 burial mound. It has been observed in males (E, 9, C) and females (G) as well. On the other hand, the extended position of the arm occurred only in male burials (D, C, F).

There was less variety in the position of the lower limbs. They were generally straight and parallel, with the feet in extension or hyperextension. In two burials (A and G), the legs were slightly bent at the knee (right lateral flexion), probably due to the small size of the pit in the case of burial A. The feet of this last skeleton were crossed at the ankle with the left foot over the right. This variety could be related to sex because burials A and G were female.

Ornaments and grave goods

There were few durable grave goods and ornaments were found only in male burials. They consist of both traditional and European objects.

A blue glass trade bead was found between the proximal extremities of the tibia in burial C. With a hexagonal shape and hexagonal facets, this bead was 5 mm long. It could be a component of a knee ornament like the very tiny glass trade beads found around the knees in burial F. These tiny glass beads are of different colours: white, pink, green, blue and black; some are bicoloured (white inside and pink inside). They were associated with very small shell beads. Similar glass trade beads were also found at the neck level in burials C and 9. Tiny glass trade beads were used in Fiji during the 1800s, especially a white bead on strings of pendants (Clunie 1986). They appear with chiefs' *Spondylus* shell pendants (*sovui*), worn by high-ranking males and females. They also adorned earlobe ornaments (*saunidaliga*) and combs (*i serusasa*), sometimes of Tongan manufacture, and were often used as hair or beard ornaments.

A *Trochus* shell armband (*qato*) with an external diameter of 104 mm was around the right elbow in burial D (Fig. 6). A boar tusk, with an external diameter of 116 mm and three holes at the proximal extremity, was found in the neck area of burial C. In Fiji, this ornament (*batinivuaka*) was worn by males at the very base of the neck. Tiny glass trade beads were also found in the vicinity of this tooth in burial C. It is difficult to know whether these two types of components formed one or more adornments. However, strings of boar-tusk pendants could have been strung with tiny glass trade beads (Clunie 1986:157). Fijian chiefs wore these two types of traditional ornaments, *Trochus* armband and boar tusk, in the 19th century, as shown by the iconography of the time.

In addition, a small shark tooth was near the head, above the left shoulder of one individual (E). It could be a part of a pendant or of a weapon; however the identification and significance of this artefact require investigation. Another feature was a piece of coral about 15 cm long found on the right ribs in burial D (Fig. 6). It had followed the ribs' subsidence, indicating that it had not penetrated the chest. Its sharpened extremity, 1 cm diameter, was on the thoracic vertebrae and the opposite extremity, with a 3 cm diameter, was on the lateral part of the ribs. The interpretation of this feature is still tentative. Given the location, the size and the shape, it could be a coral *tabua*. Such a possibility is proposed by Parke (1993, 1998) for a burial excavated in the Navatanitawake ceremonial mound in Bau Island, showing a skeleton lying with the arms folded on the chest and a round stone placed on the wrists. About the funerary *tabua* of pandanus wood (*vatunibalawa*) of a chief from Nalawa (northeast Viti Levu), Clunie (1986:177) notes that: "A *tabua* was, like a war club or musket, meant to accompany the corpse of a man in the grave, both tooth and weapon playing vital roles on the hazardous trek of his spirit to the after world ... In some cases a wooden *tabua* was used instead of an ivory one, this apparently being sufficient to beguile the demon guardians of the spirit path". Further, Routledge (1994:214) provides the following definition of *tabua* as an "object of ritual exchange formerly of wood, stone or shell, since the advent of European whaling a whale's tooth", corroborating the hypothesis that this piece of coral could have been used as a funerary *tabua*.

Finally, the distribution of the ornaments in the burial complex CIK037D does not seem to be linked to the orientation of the bodies or to the location of the burials in the mound. However, it is worth noting that the richer burials (D, C) occupied the central places, with the larger enclosures and having thicker grave fill, which could be an indication of their high-ranking status.

Wrapped in bark clothes?

Dark and brown stains thought to have been due to the decomposition of mats and/or tapa-cloth wrapping have been noticed in some West Polynesian burial sites (Davidson 1969; Sand and Valentin 1991; Spennemann and Franke 1994; Burley 1997; Sand 1998, 1999). No traces of decomposed mats or bark cloth were observed in CIK037D. However, the detailed analysis of the bones' organisation, including the taphonomic process, allows such a possibility since the tightness of the body extension is weak evidence of a bark-cloth wrapping.

In CIK037D all the burials were probably quickly interred because the skeletons were fairly articulated. Even most of the very fragile and unstable joints like those of hands and feet were in good condition. Evidence was encountered, for example, in C where, despite the location of the left upper limb extending slightly outspread from the body lying on the edge of the pit, the articulations of the folded hand were maintained (Fig. 5), and in E where both hands, covering the homolateral humeral head in a very unstable position, appear fully articulated. The feet display the same picture of good preservation of the anatomical relations (Fig. 7).

The feet are also instructive owing to their bone arrangements. Those of five individuals (D, C, E, F, B) were in hyperextension with the ankle and the hallux in continuation of the leg. Moreover, the toes of two (D and C) were turned down, in a clearly unnatural position. They show a fairly

Fig. 5. At left is a view of burial C and at right burial F.

consistent pattern. This last effect, almost systematic, could be due to a pit or the former presence of a container made in perishable material. In addition, another disturbance effect was noticeable in the lower part of the body in four individuals. In burial D, the left innominate bone, which did not lie on the edge of the pit, had kept its natural position and a disturbance effect was revealed by the alignment of the left metatarsals, fibula and iliac crest (Fig. 6). This occurs inside the probable outline of the pit. Other possible disturbance effects appear in the lower part of the body in three other burials (on the left side in burial E and on the right side in burials C and 9). Occurring inside the outline of the pit, they probably are not due to pit edges. However, other signs of constraint were due to the shape of the pit. They are the constriction of the shoulders (A, B, F) and of the humerus (A), and the placement of the clavicle parallel to the vertebral column (A, B, F, 9)

All skeletons show numerous and minor discrepancies in the bone arrangement in some anatomical regions. Bone misplacements were of two kinds: inside the body volume and outside. The movements usually occurred inside the body volume. The flattening of the ribs (D, E, A, G, C, B, F, 9); the disordering of the vertebral column (D, C, B); the opening and the setting flat of the pelvis (D, E, A, G, C, B, F, 9); the lateral rotation of the lower limbs (E) including the lateral fall of the patella (F, 9), were noticed in most of the skeletons. In some burials, the unstable position of the bones had generated minor disjunctions in some other places, especially round the elbow (A), the knee (F), the legs (A, E). In burial A the head faces northeast while the first cervical vertebrae (atlas and axis) exhibit their anterior surfaces. This anatomical contradiction probably results from a displacement during body decomposition. The sliding of the right innominate and femora toward the middle of burial C can be mentioned, as well as the sliding of ribs toward the vertebral column, revealing the left scapula, in burial F.

However, some displacements are clearly outside the body volume. In burial G, the left patella lies on its posterior surface laterally to the femoral condyle and there is a gap of more than 3 cm between the distal extremities of the radius and ulna on both sides. Finally, a sliding of the radius

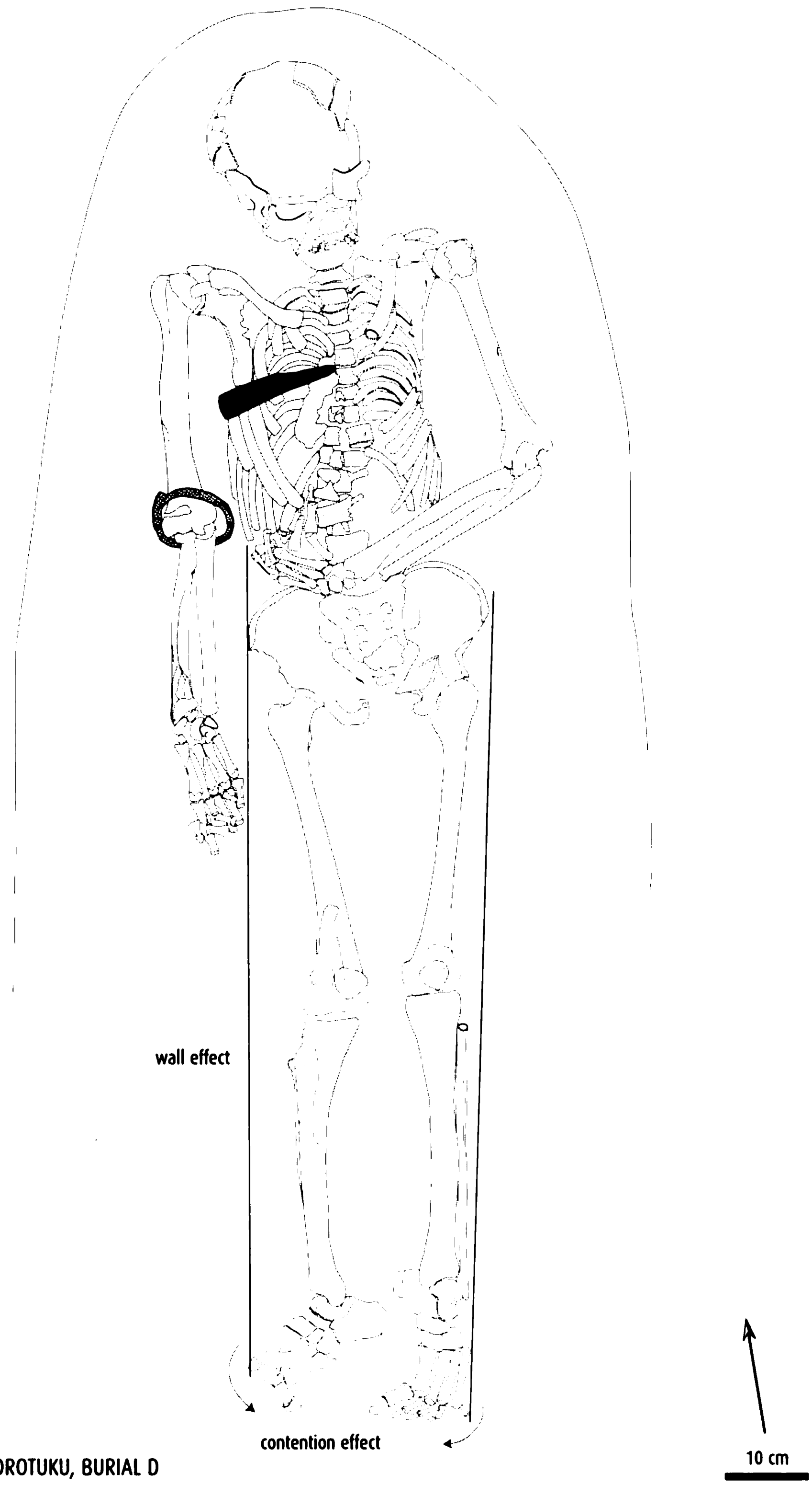

Fig. 6. Drawing of the skeleton found in burial D of the CIK037D burial mound.

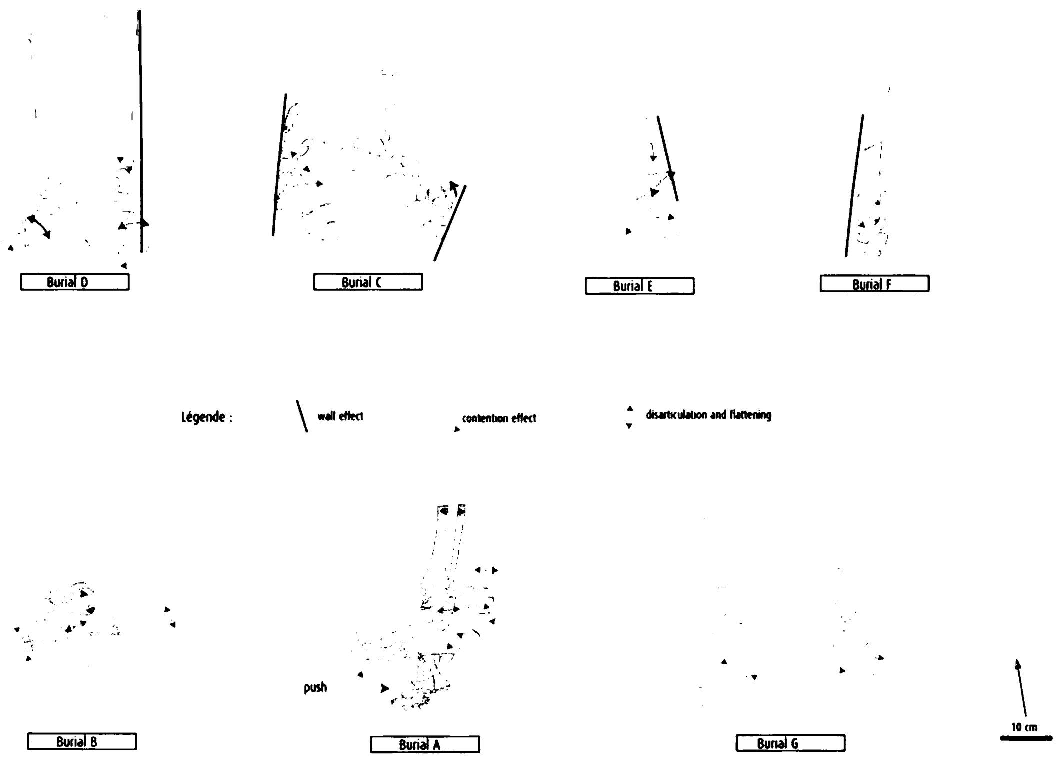

Fig. 7. Drawing showing the feet positions in each burial of the CIK037D burial mound.

toward the middle of the burial involving also the bones of the hands was observed on both sides of the skeleton in F (Fig. 5). This displacement would have occurred at the beginning of the decomposition process because the bones of the hands have kept their general anatomical coherence.

These observations indicate that the grave fill has not immediately replaced the decomposed parts of the body and has caused temporary spaces where disarticulated bones can move. They allow us to conclude that the final position that the skeletons were found in was delayed in several places in all burials. This could result from the presence of a container because it is difficult to accept that most of the movement derives from pit edge. As the bones had rarely moved outside the body, the relatively quick arrival of replacement sediment in the grave and, indirectly, the non-durable nature of the envelope which probably was wrapped around the bodies are attested. The effects described above are consistent with this hypothesis.

Finally, the detailed analysis of skeleton positioning presented above indicates the probable existence of a non-durable and flexible burial container. The hypothesis of a wrapping of the bodies in bark cloth and / or mats seems acceptable. Such an envelope seems to tightly hug the lower limbs with a clear constraining effect around the feet, especially in the large central burials (C, D) where the toes are in an unnatural position. Some variety in the pre-sepulchral treatment of the bodies can be advanced because different taphonomic results were observed. The gaps could have persisted longer or been larger in the lateral graves (A, G, F). This variation could be related to three factors. It could result from a sexual differentiation because females are in the lateral burial (A, G) while males are mostly in the medial graves (E, 9, D, C). It also could be due to social status because the individuals with constrained lower limbs are interred north–south in the larger and deeper graves which also have the richer ornaments. It might also indicate a temporal change in the burial custom of the Cikobia people.

Conclusion

The first steps of the analysis permit some concluding remarks. The Cikobia CIK037D burial mound, despite its small size (10 m by 7 m), results from the progressive combination of burials marked at the surface of the mound by seven stone arrangements. Excavation has provided the remains of 10 individuals, among which were two immature and two female burials. Even though the remains of 10 people occupied the same funerary space, this burial complex cannot be ascribed to a mass burial or a collective burial because each of the deceased was buried in an individual pit.

The presence of glass trade beads among four of the burials indicates that the CIK037D mound was built after the first European contact in this area of the Pacific. The inhabitants of Cikobia could have received them by direct contact or through contact with other Oceanic people. In either case, the CIK037D burial mound was likely to have been erected during the early 19th century.

Starting with two burials, the mound became a centre around which other burials were placed. An individual was also added between the two earlier interments. The first burials (D, E) have independent enclosures, a large sepulchral space and a thick grave fill with a north-south orientation. They contained males interred with adornments and whose lower limbs were tightly wrapped. The lateral burials (A, G, F) have enclosures resulting from the reuse of previous walls, but faced with beach rock slabs and with a small internal space. In them were placed males and females with ornaments, who have experienced another sepulchral treatment including a different wrapping.

Despite some variation in the funerary treatment and in the architecture, and noting the adornments and the energy expenditure involved in the construction, this burial mound might have been devoted to high-ranking people. Alternatively, the complexity of the burial structure and treatment reflects "relative socio-political status" of the interred individuals, if the proposal of Kirch (1988) is followed. The variation could indicate social distinctions but the architectural change could also reveal an evolution in the burial practices of the Cikobia people.

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The archaeology of Lapita dispersal in Oceania

Papers from the Fourth Lapita Conference, June 2000, Canberra, Australia

THE ARCHAEOLOGY OF LAPITA DISPERSAL publishes refereed papers from the Fourth Lapita Conference held in Canberra, 2000. Lapita archaeology is of fundamental importance to understanding the Pacific since it unearths information about the first people to establish themselves beyond the Solomon Islands to as far east as Samoa around 3000 years ago, and whose descendants eventually colonised Polynesia. The wide distribution of Lapita, its relatively rapid spread, debate about its origin, composition and mode of dispersal, and the meanings to be extracted from its distinctive and often striking ceramics are issues that underpin a sustained interest in it regionally and also from perspectives in world archaeology. This volume reports new results and interpretations about the nature of the Lapita phenomena and the varied transformations that affected Lapita society.

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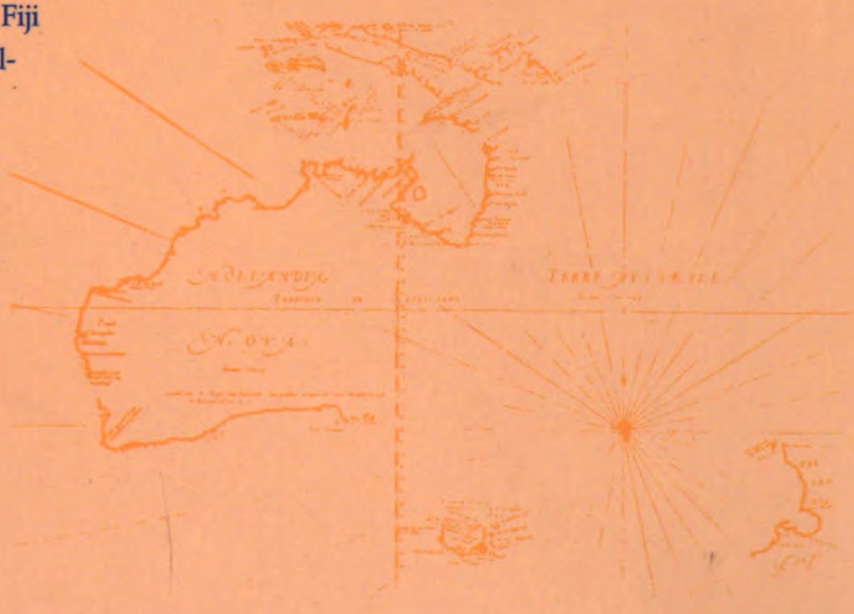

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